

## PATENT

**CARD SHUFFLER WITH READING CAPABILITY**  
**INTEGRATED INTO MULTIPLAYER AUTOMATED GAMING TABLE**

5     **Related Applications**

This application is a continuation-in-part of U.S. Patent Application Serial No. 10/623,223 filed July 17, 2003, titled "CARD SHUFFLER WITH CARD RANK AND VALUE READING CAPABILITY, which is in turn a continuation-in-part of U.S. Patent Application Serial No. 10/261,166 filed September 27, 2002, titled CARD SHUFFLING APPARATUS WITH AUTOMATIC CARD SIZE CALIBRATION which, is in turn a continuation-in-part of Application Serial No. 10/128,532 filed April 23, 2002, now U.S. Patent 6,651,982, titled CARD SHUFFLING APPARATUS WITH INTEGRAL CARD DELIVERY, which is in turn a continuation-in-part of Application Serial No. 09/967,502 filed September 28, 2001, now U.S. Patent 6,651,981, titled CARD SHUFFLING APPARATUS WITH INTEGRAL CARD DELIVERY.

**BACKGROUND OF THE INVENTION**

1. Field of the Invention

The present invention relates to the field of gaming, the field of casino table gaming, the field of casino table card gaming, and to electronic or computer-based systems that can approach or achieve complete automation of a casino table game, except that it may be used in jurisdictions that require that card delivery is determined on the basis of physical playing cards, even in a system including the elimination of an actual dealer and actual playing cards that are used by players and/or the dealer in the play of the card game.. This invention also relates to a preferred shuffling and sorting apparatus for providing randomly arranged articles and especially to the shuffling of playing cards for gaming uses. The invention also relates to a method and apparatus for providing randomly shuffled deck(s) of cards in a rapid and efficient manner and a capability of automatically calibrating the apparatus for various card sizes, card thicknesses, and for

initial setup and having card reading capability for providing information on card rank and/or card suit on cards within the shuffler. The invention also relates to a device that can verify a set of cards (one or more decks) in a rapid non-randomizing event.

5        2. Background of the Art

          In the gaming industry, significant gambling occurs at live table games that use playing cards and a live dealer. Exemplary live table games include blackjack, poker, poker variants such as Let It Ride® stud poker, baccarat, casino war and other games. There are a number of proprietary or specialty live table card games which have developed, such as Pai-Gow poker, Let-It-Ride® stud poker, Three Card Poker® game, 10        Four Card Poker® game, Caribbean Stud® poker and others. These and many other games all involve play using playing cards. The cards are dealt by a live dealer to the players, to a flop and/or to the dealer. The use of playing cards provided by a live dealer has a number of associated limitations and disadvantages that have long plagued the casino industry. Some of these are of general concern to all or most playing card games. 15        Others are problems associated with the use of playing cards in particular games. Some of the principal concerns and problems are discussed below.

          The use of playing cards at live table games typically involves several operational requirements that are time-consuming. These operations are conveniently described as 20        collecting, shuffling, dealing and reading of the cards. In many card games there is also a step of cutting the deck after it has been shuffled. In the collecting operation, a live dealer typically collects the cards just played at the end of a hand of play. This is done in preparation for playing the next hand of cards. The cards must often be collected in the specific order in which they had appeared in the play of the game and must also be 25        collected in a specific orientation, such as all cards being in a facedown or face-up condition. The cards also are typically straightened into a stack with the long sides and short sides aligned. These manipulations take time and are not typically appreciated by either the dealer or players as enhancing the play and entertainment value of the game. The use of physical cards also adds a regular cost to play of the game in the wear on

decks of cards that must be replaced every few hours. In many games the cards collected at the end of the hand are deposited in a discard rack that collects the played cards until the time a new stack is obtained or the stack is shuffled. In some games the cards are immediately shuffled into the stack either manually or using a card shuffling machine.

5 More typically, the cards are collected and then shuffling is performed later by the dealer or a shuffling device controlled by the dealer.

When shuffling is needed, it involves a break in the action of the table game and consumes a significant amount of time. Shuffling is also the most time consuming operation in preparing for the next hand. Thus, shuffling is of substantial financial  
10 significance to the casino industry because it requires significant time and reduces the number of hands that can be played per hour or other period of time. The earnings of casinos are primarily dependent upon the total number of hands played. This is true because the casino on average wins a certain percent of the amounts wagered, and many or most casinos are open on a 24-hour basis. Thus, earnings are limited by the number of  
15 hands that can be played per hour. In light of this there has been a significant and keen interest by casino owners to develop practices that allow more games to be played in a given amount of time. Accomplishing this without detracting from the players' enjoyment and desire to play the game is a challenging and longstanding issue with casino owners and consultants in the gaming industry. The use of high quality shuffling  
20 machines, such as those produced by Shuffle Master, Inc. (Las Vegas, Nevada) as shown in such patents as U.S. Patents Nos. 6,655,684; 6,651,982; 6,588,751; 6,658,750; 6,568,678; 6,325,373; 6,254,096; 6,149,154; 6,139,014; 6,068,258; and 5,695,189 have significantly reduced the problem in down time, but there is still the need for a human operator and a human dealer in the use of these shuffling devices for casino table games.

25 The amount of time consumed by collecting, shuffling and dealing is also of significance in private card games because it also delays action and requires some special effort to perform. In private games there is also some added complexity due to card players remembering or figuring out which player had previously dealt and who should now shuffle and re-deal the cards as needed.

In addition to the time delay and added activity needed to collect, shuffle and deal cards, there is typically some time devoted to cutting the deck of cards which have been shuffled and which are soon to be dealt. This traditional maneuver helps to reduce the risk that the dealer who has shuffled the cards may have done so in a way that stacks the deck in an ordered fashion that may favor the dealer or someone else playing the game. Although cutting the deck does not require a large amount of time, it does take some time. The amount of time spent on cutting also somewhat reduces the frequency at which hands of the card game can be played and introduces another physical step in which human error or design can be introduced, such as dropping and exposing the cards or cutting the deck in a specific position to control the outcome in a fixed deck.

In the gaming industry there is also a very significant amount of time and effort devoted to security issues that relate to play of the casino games. Part of the security concerns stem from frequent attempts to cheat during play of the games. Attempts to cheat are made by players, dealers, or more significantly by dealers and players in collusion. This cheating seeks to affect the outcome of the game in a way that favors the dealer or players who are working together. The amount of cheating in card games is significant to the casino industry and constitutes a major security problem that has large associated losses. The costs of efforts to deter or prevent cheating are very large and made on a daily basis. Many of the attempts to cheat in the play of live table card games involve some aspect of dealer or player manipulation of cards during collection, shuffling, cutting or dealing of cards. Thus, there is a need for methods and apparatus that can be used in the play of live table card games that reduce the ability of the dealer and/or players to cheat by manipulation of playing cards. Of greatest concern are schemes whereby the deck is stacked and the stacked deck is used to the collusive player's advantage. Stacked decks represent huge potential losses since the player is aware of the cards which will be played before play occurs and can optimize winnings by increasing bets for winning hands and decreasing bets for losing hands. It is also desirable to provide decks or groups of cards where card counters are disadvantaged because of the reduction in their ability to track distributions of cards in the group of cards being used for play.

Continuous shufflers, in which cards are reintroduced into the group of cards being used, the introduction being random throughout the entire group, helps to eliminate that aspect of improper behavior at the gaming table.

Casinos have recognized that their efforts to reduce cheating would be improved if the casino had comprehensive information on the cards which have been played, the amounts bet, the players and dealers involved and other information about actions which have taken place at the card tables. This is of particular importance in assessing the use of stacked decks. It is also important where card tracking is occurring. Additional explanation about card tracking is discussed below. The information desired by the casinos includes knowing the sequence and exact cards being dealt. It would be even more advantageous to the casino if physical cards and live dealers could be eliminated, as this would remove almost all major existing methods of fraud from casino table card games.

Some attempts have been made to record card game action. The best current technology involves cameras that are mounted above the tables to record the action of the card games. This approach is disadvantaged by the fact that not all cards dealt are easily imaged from a camera position above the table because some or all of the cards are not dealt face-up, or are hidden by overlying cards. Although many blackjack games are sufficiently revealing to later determine the order of dealt cards, others are not. Other card games, such as poker, have hands that are not revealed. The covered cards of the players do not allow the order of dealt cards to be ascertained from an above-table camera or on table cameras, as exemplified by U.S. Patents Nos. 6,313,871 (Schubert); 5,781,647 (Fishbine); and numerous patents assigned to MindPlay LLC (e.g., U.S. Patent Nos. 6,663,490; 6,652,379; 6,638,161; 6,595,857; 6,579,181; 6,579,180; 6,533,662; 6,533,276; 6,530,837; 6,530,836; 6,527,271; 6,520,857; 6,517,436; 6,517,435; and 6,460,848.

Even where cameras are used, their use may not be effective. Such cameras may require time-consuming and tedious human analysis to go over the videotapes or other recordings of table action or require the use of software that is complex and imprecise. In some present systems, some human study may be needed just to ascertain the sequence of

cards dealt or to determine the amount of betting or to confirm software determinations from camera read data. Such human analysis is costly and cannot economically be used to routinely monitor all action in a casino card room or table game pit.

For the above reasons, the video camera monitoring techniques have found very limited effectiveness as a routine approach for identifying cheating. There has also been relatively limited use as a serious analytical tool because of the difficulty of analysis. Such camera surveillance techniques are also of only limited effectiveness as a deterrent because many of the people involved with cheating have a working knowledge of their limitations and utilize approaches which are not easily detectable by such systems.

Another use of video camera monitoring and recording has been made in the context of analyzing card table action after someone has become a cheating or card counting suspect. The tape recordings serve as evidence to prove the cheating scheme. However, in the past, this has generally required other evidence to initially reveal the cheating so that careful analysis can be performed. More routine and general screening to detect cheating has remained a difficult and continuing problem for casinos. This is also a human intensive review, with both video monitoring security personnel and live personnel watching the players and apprehending players at the tables.

Another approach to reducing security problems utilizes card shoes having card detection capability. Card shoes hold a stack of cards containing typically from one to eight decks of cards. The cards are held in the card shoe in preparation for dealing and to secure the deck within a device that restricts access to the cards and helps prevent card manipulations. Card shoes can be fit with optical or magnetic sensors that detect the cards as they are being dealt. Some of the problems of security analysis using above-table cameras is reduced when the sequence of cards dealt can be directly determined at the card shoe using optical or magnetic sensors.

One advantage of such card shoes is that the card sequence information can be collected in a machine-readable format by sensing the specific nature (suit and count) of each card as they are dealt out of the card shoe. However, most such card shoes have special requirements for the cards being used. Such cards must carry magnetic coding or

are specifically adapted for optical reading. This increases the cost of the cards and may not fully resolve the problems and difficulties in obtaining accurate information concerning sequence information. The automated data collecting card shoes also do not have an inherent means for collecting data on the assignment of the card to a particular player or the dealer. They further do not collect data on the amounts bet. These factors thus require some other manual or partially automated data collection system to be used, or require that time-consuming human analysis be performed using video tapes as explained above.

The use in blackjack of numerous card decks, such as six decks, has been one strategy directed at minimizing the risk of card tracking or counting, especially when the set of cards is cut relatively shallowly so that many cards are not allowed into play from the set. Such tracking should be contrasted with card counting strategies which are typically less accurate and do not pose as substantial a risk of loss to the casino. Use of numerous card decks in a stack along with proper cut card placement can also reduce the risk of effective card counting. However, it has been found that multiple decks are not sufficient to overcome the skilled gambler's ability to track cards and turn the advantage against the house.

Card tracking can be thought of as being of two types. Sequential card tracking involves determination of the specific ordering of the card deck or decks being dealt. This can be determined or closely estimated for runs of cards, sequences of cards forming a portion or portions of a stack. Sequential card tracking can be devastating to a casino since a player taking advantage of such information can bet large in a winning situation and change the odds in favor of the player and against the casino.

Slug tracking involves determining runs of the deck or stack that show a higher frequency of certain important cards. For example, in the play of blackjack there are a relatively large number of 10-count cards. These 10-count cards are significant in producing winning blackjack hands or 20-count hands that are also frequently winning hands. Gamblers who are proficient in tracking slugs containing large numbers of 10-count cards can gain an advantage over the house and win in blackjack.

There is also a long-standing problem in the play of blackjack which concerns the situation when the dealer receives a blackjack hand in the initial two cards dealt. If the dealer has a 10-count card or ace as the up card, then it is possible for the dealer to have a blackjack. If the dealer does have a blackjack, then there is no reason to play the hand out since the outcome of the hand is already determined without further dealing. If the hand is fully played out, and the dealer then reveals that the dealer has received a blackjack hand, then a significant amount of time has been wasted. It also causes players to often be upset when a hand is played out to no avail. In many casinos the waste of time associated with playing out hands with a winning dealer blackjack has lead to various approaches that attempt to end the hand after the initial deal. Some of these allow the dealer to look at the down card to make a determination whether a blackjack hand has been dealt to the dealer. This looking is commonly called "peeking" and is an operation that has been the source of numerous cheating schemes involving dealers and players who work in collusion. In such cheating associated with peeking at the down card, the dealer cheats in collaboration with an accomplice-player. This cheating is frequently accomplished when the dealer signals the accomplice using eye movements, hand movements or other signals. If a dealer does not peek, then he does not know the value of his hand until after the players have completed their play. If the dealer does peek, then he can use such eye movements, hand movements or other techniques to convey instructions to his accomplice-player. These signals tell the accomplice what hand the dealer has been dealt. With this knowledge of the dealer's hand, the accomplice has improved odds of winning and this can be sufficient to turn the long-term odds in favor of the accomplice-player and against the casino. Many casinos do not allow the dealer to look at or inspect the down card until all insurance wagers have been made or declined.

There have also been a substantial number of apparatuses devised to facilitate the peeking procedure or render it less subject to abuse. Such peeking devices are intended to allow determination of whether the dealer has received a blackjack hand; however, this is done without revealing to the dealer what the down card is unless it makes a blackjack. Some of these devices require a special table with a peeking device installed in the table.



Others allow the down card to be reviewed using a tabletop device in which the card is inserted. These systems and others involve the use of special playing cards. These devices and methods generally add greater costs and slow the play of the game. The slowed play often occurs to such a degree that it offsets the original purpose of saving the time associated with playing out possible dealer blackjack hands. The prior attempts have often ended up unacceptable and are removed.

Another notable problem suffered by live table games is the intimidation which many novice or less experienced players feel when playing such games. Surveys have indicated that many new or less experienced people who come to a casino are inclined to play slot machines and video card games. These people feel intimidation at a live table game because such games require quick thinking and decision making while other people are watching and waiting. This intimidation factor reduces participation in table games.

A further issue that has developed in the casino business is the public's increasing interest in participating in games that have a very large potential payoff. This may be in part a result of the large amount of publicity surrounding the state operated lotteries. News of huge payoffs is read with keen interest and creates expectations that gaming establishments should provide games with large jackpots. One approach has been the networked or progressive slot machines that use a centralized pool of funds contributed by numerous players. These slot machine systems are relatively more costly to purchase and operate. For many gamblers, this approach is not particularly attractive. This lack of attractiveness may be due to the impersonal and solitary nature of playing slot machines. It may alternatively be for other reasons. Whatever the reason, the public is clearly interested in participating in games that can offer potential jackpots that are very large. Table card games have not been able to satisfactorily address this interest. The continued diminishment in the percent of people who play live table games indicates the need for more attractive games and game systems that address to public's interests.

Further problems associated with live table card games are the costs associated with purchasing, handling and disposal of paper and plastic playing cards. Casinos pay relatively favorable prices for card decks, but the decks roughly cost about \$1 per deck at

this time. Each casino uses decks for a very limited period of time, typically only one shift, and almost always less than one day. After this relatively brief life in the limelight, the decks are disposed of in a suitable manner. In some cases they can be sold as souvenirs. This is done after the cards are specially marked or portions are punched out to show they have been decommissioned from a casino. This special marking allows the cards to be sold as souvenirs while reducing the risk that they will later be used at the card tables in a cheating scheme which involves slipping a winning card into play at an appropriate point. In other cases the playing cards are simply destroyed or recycled to eliminate this last risk. In any case, the cost of playing cards for a casino is significant and can easily run in the hundreds of thousands of dollars per year.

In addition to the above problems, there are also significant costs associated with handling and storing the new and worn playing cards. Sizable rooms located in the casino complexes are needed just to store the cards as they are coming and going. Thus, the high costs of casino facilities further exacerbate the costs associated with paper and plastic playing cards.

The most significant cost in operation of gaming apparatus is personnel costs. A number of attempts have been made to reduce time requirements for not only the dealers, relief dealers, but also for the supervisors, managers, security and the other staff that are directly or indirectly involved in the operation or maintenance of the games.

A number of attempts have been made to design and provide fully automated gaming machines that duplicate play of casino table card games. These attempts have ranged from and included the highly successful video poker slot games to the mildly successful slot-type blackjack game (for single players). In those systems, the individual player sits at an individual machine, inserts credits/currency/coins, and plays a one-on-one game that is controlled by a processor in the machine or to which the machine is distally connected (networked). These machines are common in casinos, but do not duplicate the ambience of the casino table game with multiple players present.

Another type of attempt for simulating casino table card games is the use of a bank of individual player positions associated with a single dealer position in an attempt

to simulate the physical ambiance of a live casino table card game. Such systems are shown in U.S. Patents Nos. 4,397,509 (Miller); 4,614,342 (Takashima); 4,995,615 (Cheng); 5,470,080 (Naku); and Published U.S. Patent Applications 2002/0169013 (Serizawa); 2003/0199316 (Miyamoto); and the like. These systems have a video display of a dealer and have individual monitors for display of the players' hands and the dealer hands. The architecture of these systems has generally been designed on a unique basis for each game, and there tends to be a main computer/processor that drives all elements of the game, or two computers/processors that distribute the video control of the dealer image and the remainder of the game elements between the two distinct computer/processors. This tends to maximize the cost of the system and tends to provide a slow system with high processing power demands to keep the operation working at speeds needed to maximize use and profit from the machines.

Sines U.S. patents 6,651,985 and 6,270,404 are titled "Automated system for playing live casino table games having tabletop changeable playing card displays and play monitoring security features." Sines U.S. Patent 6,165,069 is similarly titled "Automated system for playing live casino table games having tabletop changeable playing card displays and monitoring security features."

The latter two patents (6,270,404 and 6,165,069) are related as continuations and therefore have identical disclosures. U.S. Patent 6,651,985 claims continuation-in-part status from the earliest application (U 6,165,069).

Sines, U.S. Patent 6,651,985, describes the use of a live dealer, even though virtual cards are used. There is no virtual dealer display and no software or architecture controls needed for a virtual dealer display. There are distinct display components for the players' hands and dealer's hand. Looking at Figures 23, 24 and 25 (which are identical to the same figures in U.S. Patent 6,651,895, discussed above), it appears that at least for betting functions, the system operates with parallel communication to the player input stations. (See wire connections shown in Figures 24 and 25 to the Player Bet Interfaces 196, 198, 201 and 203.) These Bet Interface Circuits (an alternative description in the text, at column 14, lines 29-56 and column 15, lines 5-12) do not indicate that these are

anything more than circuits, and no processing intelligence is specifically disclosed. This appears to be merely an interface with player controls without any processing function disclosed. The Sines' system in these patents also requires bet sensors on the table.

U.S. Patent No. 6,607,443 (Miyamoto et al., Kabushiki Kaisha SEGA Enterprises) and Published U.S. Application 2003/0199316 A1 (also KKSE) and particularly Figures 1, 2, 3, 7, 9, 10, 11, 12 and 13, discloses a virtual blackjack table system. The main objective of this patent is to have optical data that enables the SEGA system to read hand signals of players, such as calls for hits and Stand signals. The hardware architecture in Figure 15, as described in the specification at column 11, lines 29-54 show that there are distinct CPU's for the (audio and video, 280, 281, 282, 283) which is driven by the Sub-CPU, which is turn connected to the main CPU (201), with an additional sub-CPU 204 directing the motion sensor system 13, 14, 15, 16, and 32. There are distinct processing blocks for the sound (22), the video (21), the main CPU (20), and the subsystems (13), as well as the components already noted for the motion sensors/facial recognition sensors system.

U.S. Patent No. 5,221,083 (Dote, SEGA Enterprises, Ltd.) describes a blackjack automated game system that has a reflected video image of a dealer and also has individual satellite player positions, with individual CRT monitors for each player. There is no disclosure of the type of information processing hardware in the system.

U.S. Patent Nos. 5,934,998 (Forte and Sines, unassigned) and 5,586,766 (Forte and Sines, assigned to Casinovations, Inc.) describe the use of physical cards and a physical dealer, with no dealer display, on a blackjack table that has a CPU driven system. Figures 6-10 show circuit construction and hardware considerations in the design of the system, including communication architecture. This system provides a count display (e.g., LED display) at each player position to show the player count and dealer count (as appropriate) that is determined from reading of the physical cards. Physical playing chips are also used, with no credit wagering capability shown.

U.S. Patent No. 5,159,549 describes a system that provides a multiple player game data processing unit with wager accounting. There are distinct player stations with

player input on wagering. There may be a limited amount of intelligence at player stations (see column 4, line 1 through column 7, line 55), but there are multiple lines to each player station.

U.S. Patent No. 4,614,342 (Takashima) teaches an electronic game machine with distinct display units (CRT screens) at the player positions and the dealer position. The dealer screen (10) does not show an image of a dealer, but shows the dealer's card(s) and game information. There are typical player input controls (16) at each player position. The system provided is more like a bank of slot systems than a card table. In addition to a dealer data processor (6), each player position includes a player data processor CPU (30) with player memory (32). The central dealer computer apparently polls the individual player data processors to obtain the status of the events at each position (column 4, lines 1-60; and column 3, lines 8-17).

U.S. Patent No. 5,586,936 (Bennett et al., assigned to Mikohn Gaming) teaches a ticketless control system for monitoring player activity at a table game, such as blackjack. Physical cards and physical chips are shown. Player identity cards identify each player entering play at a table, and a separate ticket printer issues a results ticket (500) at the end of play or reads the ticket at the beginning of play. There is no distinct intelligence apparent at each player position, and there is a central CPU that controls the system (e.g., Figure 8). Physical chips and a real dealer are apparently used. A phone line (630) is connected from each player position to the CPU (820) through a communications port (814).

U.S. Patent No. 4,995,615 (Cheng) describes a method and apparatus for performing fair card play. There are individual player positions with individual screens (12) provided for each player. There are three vertical, card-display screens (11, 13, 11) shown for "receiving instructions from the computer to display sequentially the cards being distributed throughout the processing of the play..." (Column 4, lines 4-13). There is no visual display of a dealer, there are individual player image panels, and no details of the architecture are shown or described.

U.S. Patents Nos. 5,879,235; 5,976,019; and 6,394,898, assigned to SEGA Enterprises, Ltd. relate to non-card game systems, such as horse race simulators or ball game simulators (e.g., roulette). There is no dealer or croupier simulation. The horse race simulator is an automated miniature track with physically moving game elements.

5 The system again shows individual monitors at each player position (80, 81) and no dealer display. The schematics of the electrical architecture in Figure 11 shows a main board that also includes a Picture Control Section (95), Sound Control Section (96), and a communication control section (107). There is a distinct picture output board (108).

It is desirable to provide a system that meets both the structural and play

10 ambience requirements for a successful, fully automated interactive gaming system for playing casino table wagering games with cards that does not require any attendant personnel in its operation.

#### **SUMMARY OF THE INVENTION**

A gaming system simulates complete play of events in a casino table card

15 wagering game, such as blackjack, poker, poker variants, baccarat, and other wagering games where there has traditionally been a dealer, whether or not the dealer is an active player in the game. Two distinct video areas are preferably provided, one relatively upright video display providing video images of a virtual dealer, and the second relatively horizontal video display providing a simulation of a tabletop for player cards, optionally

20 also dealer cards and wagers. The players have individual play areas with player input, and these play areas have individual processing intelligence that communicates directly with a main game computer in a novel manner.

It is desirable to provide a system that meets both the structural and play

25 ambience requirements for a successful, fully automated interactive gaming system for playing casino table wagering games with cards that does not require any attendant personnel in its operation. However, certain jurisdictions do not allow the play of card games where the symbols distributed to players are completely virtual, including a virtual, electronic "shuffling" of the virtual cards. This would prevent the introduction of a completely automated game into those jurisdictions.

In the gaming industry, certain games require that batches of randomly shuffled cards be provided to players and sometimes to dealers in live card games. It is important that the cards are shuffled thoroughly and randomly to prevent players from having an advantage by knowing the position of specific cards or groups of cards in the final arrangement of cards delivered in the play of the game. At the same time, it is advantageous to have the deck(s) shuffled in a very short period of time so that there is minimal down time in the play of the game.

Breeding et al., U.S. Patent Nos. 6,139,014 and 6,068,258 (assigned to Shuffle Master, Inc.) describe a machine for shuffling multiple decks of playing cards in a batch-type process. The device includes a first vertically extending magazine for holding a stack of unshuffled playing cards, and second and third vertically extending magazines each for holding a stack of cards, the second and third magazines being horizontally spaced from and adjacent to the first magazine. A first card mover is positioned at the top of the first magazine for moving cards from the top of the stack of cards in the first magazine to the second and third magazines to cut the stack of unshuffled playing cards into two unshuffled stacks. Second and third card movers are at the top of the second and third magazines, respectively, for randomly moving cards from the top of the stack of cards in the second and third magazines, respectively, back to the first magazine, thereby interleaving the cards to form a vertically registered stack of shuffled cards in the first magazine. Elevators are provided in the magazines to bring the cards into contact with the card movers. This shuffler design is currently marketed under the name MD-1™ shuffler and MD1.1™ shuffler in the United States and abroad.

Sines et al. U.S. Patent No. 6,019,368 describes a playing card shuffler having an unshuffled stack holder that holds an in-feed array of playing cards. One or more ejectors are mounted adjacent the unshuffled stack holder to eject cards from the in-feed array at various random positions. Multiple ejectors are preferably mounted on a movable carriage. Extractors are used to assist in removing playing cards from the in-feed array. Removal resistors are used to provide counteracting forces resisting displacement of cards, to thereby provide more selective ejection of cards from the in-feed array. The

automated playing card shuffler comprises a frame; an unshuffled stack holder for holding an unshuffled array of playing cards in a stacked configuration with adjacent cards in physical contact with each other and forming an unshuffled stack; a shuffled array receiver for holding a shuffled array of playing cards; at least one ejector for  
5 ejecting playing cards located at different positions within the unshuffled stack; and a drive which is controllable to achieve a plurality of different relative positions between the unshuffled stack holder and the at least one ejector. This shuffler design is currently marketed under the name Random Ejection Shuffler™ shuffler.

Grauzer et al., U.S. Patent No. 6,149,154 (assigned to Shuffle Master, Inc.)  
10 describes an apparatus for moving playing cards from a first group of cards into plural groups, each of said plural groups containing a random arrangement of cards, said apparatus comprising: a card receiver for receiving the first group of unshuffled cards; a single stack of card-receiving compartments generally adjacent to the card receiver, said stack generally adjacent to and movable with respect to the first group of cards; and a  
15 drive mechanism that moves the stack by means of translation relative to the first group of unshuffled cards; a card-moving mechanism between the card receiver and the stack; and a processing unit that controls the card-moving mechanism and the drive mechanism so that a selected quantity of cards is moved into a selected number of compartments. This shuffler is currently marketed under the name ACE® shuffler in the United States  
20 and abroad.

Grauzer et al., U.S. Patent No. 6,254,096 (assigned to Shuffle Master, Inc.) describes an apparatus for continuously shuffling playing cards, said apparatus comprising: a card receiver for receiving a first group of cards; a single stack of card-receiving compartments generally adjacent to the card receiver, said stack generally  
25 vertically movable, wherein the compartments translate substantially vertically, and means for moving the stack; a card-moving mechanism between the card receiver and the stack; a processing unit that controls the card-moving mechanism and the means for moving the stack so that cards placed in the card receiver are moved into selected compartments; a second card receiver for receiving cards from the compartments; and a



second card-moving mechanism between the compartments and the second card receiver for moving cards from the compartments to the second card receiver. This shuffler design is marketed under the name KING™ shuffler in the United States and abroad.

Johnson et al., U.S. Patent No. 5,944,310 describes a card handling apparatus comprising: a loading station for receiving cards to be shuffled; a chamber to receive a main stack of cards; delivery means for delivering individual cards from the loading station to the chamber; a dispensing station to dispense individual cards for a card game; transfer means for transferring a lower most card from the main stack to the dispensing station; and a dispensing sensor for sensing one of the presence and absence of a card in the dispensing station. The dispensing sensor is coupled to the transfer means to cause a transfer of a card to the dispensing station when an absence of a card in the dispensing station is sensed by the dispensing sensor. Individual cards delivered from the loading station are randomly inserted by an insertion means into different randomly selected positions in the main stack to obtain a randomly shuffled main stack from which cards are individually dispensed. The insertion means includes vertically adjustable gripping means to separate the main stack into two spaced apart sub-stacks to enable insertion of a card between the sub-stacks by the insertion means. The gripping means is vertically positionable along the edges of the main stack. After gripping, the top portion of the stack is lifted, forming two sub-stacks. At this time, a gap is created between the stacks. This shuffler is marketed under the name QUICKDRAW® shuffler in the United States and abroad.

Similarly, Johnson et al., U.S. Patent No. 5,683,085 describes an apparatus for shuffling or handling a batch of cards including a chamber in which a main stack of cards are supported, a loading station for holding a secondary stack of cards, and a card separating mechanism for separating cards at a series of positions along the main stack. The separating mechanism allows the introduction of cards from the secondary stack into the main stack at those positions. The separating mechanism grips cards at the series of positions along the stack and lifts those cards at and above the separation mechanism to define spaces in the main stack for introduction of cards from the secondary stack.

U.S. Patent No. 5,676,372 describes an automated playing card shuffler, comprising: a frame; an unshuffled stack holder for holding an unshuffled stack of playing cards; a shuffled stack receiver for holding a shuffled stack of playing cards; at least one ejector carriage mounted adjacent to said unshuffled stack holder, said at least  
5 one ejector carriage and said unshuffled stack holder mounted to provide relative movement between said unshuffled stack holder and said at least one ejector carriage; a plurality of ejectors mounted upon said at least one ejector carriage adjacent the unshuffled stack holder, for ejecting playing cards from the unshuffled stack, the ejecting occurring at various random positions along the unshuffled stack.

10 Johnson et al., U.S. Patent No. 6,267,248 describes an apparatus for arranging playing cards in a desired order, said apparatus including: a housing; a sensor to sense playing cards prior to arranging; a feeder for feeding said playing cards sequentially past the sensor; a storage assembly having a plurality of storage locations in which playing cards may be arranged in groups in a desired order, wherein the storage assembly is  
15 adapted for movement in at least two directions during shuffling; a selectively programmable computer coupled to said sensor and to said storage assembly to assemble in said storage assembly groups of playing cards in a desired order; a delivery mechanism for selectively delivering playing cards located in selected storage locations of the storage assembly; and a collector for collecting arranged groups of playing cards. The storage  
20 assembly in one example of the invention is a carousel containing a plurality of card storage compartments. The device describes card value reading capability and irregular (e.g., missing or extra) card indication.

Pending U.S. Patent Application Serial No. 09/967,502 describes a device for forming a random set of playing cards including a top surface and a bottom surface, and a  
25 card receiving area for receiving an initial set of playing cards. A randomizing system is provided for randomizing the initial set of playing cards. A collection surface is located in a card collection area for receiving randomized playing cards, the collection surface receiving cards so that all cards are received below the top surface of the device. An elevator is provided for raising the collection surface so that at least some randomized

cards are elevated at least to the top surface of the device. A system for picking up segments of stacks and inserting cards into a gap created by lifting the stack is described.

U.S. Patent No. 5,605,334 (McCrea) describes a secure game table system for monitoring each hand in a progressive live card game. The progressive live card game has at least one deck with a predetermined number of cards, the secure game table system having players at a plurality of player positions and a dealer at a dealer position. The secure game table system comprises: a shoe for holding each card from at least one deck before being dealt by the dealer in the hand, the shoe having a detector for reading at least the value and the suit of the each card, the detector issuing a signal corresponding at least to the value and suit for the each card. A card-mixing system may be combined or associated with the card-reading shoe. A progressive bet sensor is located near each of the plurality of player positions for sensing the presence of a progressive bet. When the progressive bet is sensed, the progressive bet sensor issues a signal corresponding to the presence. A card sensor located near each player positions and the dealer position issues a signal when a card in the hand is received at the card sensor. A game control has a memory and is receptive of progressive bet signals from the progressive bet sensor at each player position for storing in memory which player positions placed a progressive bet. The game control is receptive of value and suit signals from the detector in the shoe for storing in memory at least the value and suit of each card dealt from the shoe in the hand. The game control is receptive of card received signals from card sensors at each player position and dealer position for correlating in memory each card dealt from the shoe in game sequence to each card received at a player position having a progressive bet sensed. The specification indicates that FIG. 16 is an illustration setting forth the addition of a single card reader to the automatic shuffler of U.S. Pat. No. 5,356,145, In FIGS. 16 and 17 is set forth another embodiment of the secure shuffler of that 5,605,334 Patent, based upon the shuffler in Figures 12-16 of U.S. Patent No. 5,356,145. The shuffler may be mounted on a base in which is contained a camera with a lens or lenses and camera may be embedded in a base of the shuffler.

U.S. Patent No. 6,361,044 (Block) describes a top of a card table with a card dispensing hole there through and an arcuate edge is covered by a transparent dome shaped cover. A dealer position is centrally located on the tabletop. Multiple player stations are evenly spaced along the arcuate edge. A rotatable card placement assembly includes an extendable arm that is connected to a card carrier that is operable to carry a card. In response to signals from the computer, the rotation of the assembly and the extension of the arm cause the card carrier to carry the card from the card dispensing hole to either the dealer position or any of the player positions. The card carries a bar code identification thereon. A bar code reader of the card carrier provides a signal representation of the identification of the card to the computer.

U.S. Patent No. 6,403,908 (Stardust) describes an automated method and apparatus for sequencing and/or inspecting decks of playing cards. The method and apparatus utilizes pattern recognition technology or other image comparison technology to compare one or more images of a card with memory containing known images of a complete deck of playing cards to identify each card as it passes through the apparatus. Once the card is identified, it is temporarily stored in a location corresponding to or identified according to its position in a properly sequenced deck of playing cards. Once a full set of cards has been stored, the cards are released in proper sequence to a completed deck hopper. The method and apparatus also includes an operator interface capable of displaying a magnified version of potential defects or problem areas contained on a card which may be then viewed by the operator on a monitor or screen and either accepted or rejected via operator input. The device is also capable of providing an overall wear rating for each deck of playing cards.

Many other patents provide for card reading capability in different physical manners, at different locations, and in different types of apparatus from card reading shoes, to card reading racks, to table security control systems such as disclosed in U.S. Patent Nos. 4,667,959 (Pfeiffer), 6,460,848 (Soltys, MindPlay LLC), 6,270,404 (Sines, automated system); 6,217,447 (Lofink); 6,165,069 (Act) (Sines); 5,779,546; 6,117,012 (McCrea); 6,361,044 (Block); 6,250,632 (Albrecht); 6,403,908 (Stardust); 5,681,039

(Miller); 5,669,816 (Peripheral Dynamics); 5,722,893 (Smart Shoes, Inc.); 5,772,505 (Peripheral Dynamics); 6,039,650 (Smart Shoes, Inc.); 6,126,166 (Advanced Casino Technologies); 5,941,769 (Unassigned); and WO 00/51076 (Dolphin Advanced Technologies PTY. Ltd.). All of this literature with respect to the shuffling and reading of cards is incorporated herein by reference as disclosure relating to shufflers or card supplying means that can read the cards and determine the order of cards in a randomized or shuffled set of cards.

### **SUMMARY OF THE INVENTION**

A gaming system simulates complete play of events in a casino table card wagering game, such as blackjack, poker, poker variants, baccarat, and other wagering games where there has traditionally been a dealer, physical cards in play, and physical chips or money placed on the table, whether or not the dealer is an active player in the game. Two distinct video areas are preferably provided, one relatively upright video display providing virtual video images of a dealer and various background images, and the second relatively horizontal video display providing a simulation of a table top for virtual player cards, virtual chips and optionally also dealer cards. The players have individual play areas with player input, and these play areas have individual processing intelligence that communicates directly with a main game computer in a novel manner.

A device for forming a set of playing cards in a randomized order is provided, and the randomized order of the physical cards is recorded in memory. The randomized order of cards is made into an electronic file from which the automated system delivers virtual cards to the player, and where required, to the dealer or a flop. No cards are actually dealt to the players or the dealer (or flop), but the physically randomized or shuffled deck defines the electronic file from which virtual cards are to be dealt. The set of cards is reshuffled or again randomized at intervals corresponding to allowable limits of use of the set of cards. For example, a virtual and random cut may be made in the set of randomized cards, and when play of a game passes that cut, a last hand is completed, and the cards shuffled again, as is standard in conventional casino play.

A preferred device for forming a random set of playing cards is described, which is inclusive of the Shuffle Master, Inc. MD-2 shuffler with card reading capability (e.g., value, rank and suit reading capability is possible). The device includes a top surface and a bottom surface of said device and a receiving area for receiving an initial set of playing cards. A randomizing system is provided for randomizing the initial set of playing cards. A collection surface is provided in a card collection area for receiving randomized playing cards. A card feed mechanism in one form of the invention individually transfers cards from the receiving area into the card collection area. The device further includes an elevator for raising and lowering the collection surface within the card collection area.

At least one card supporting element within the card collection area supports and suspends a randomly determined number of cards within the card collection area. In one example of the invention, a pair of spaced apart gripping members are provided to grasp the opposite edges of the group of cards being suspended. A card insertion point is created in the card collection area beneath the suspended randomly determined group of cards and above the cards resting on the elevator, if any. The card feed mechanism delivers a card into the insertion point. Card values may be read at the time of or before card insertion. The cards are not required to be read as they are being removed from the shuffler (as in a reading head located in a dealer delivery portion of a shuffler), although such an additional reading capability may be added in some constructions (in addition to the internal reading of the rank and/or suit of cards) where there is a dealer card-by-card delivery section. Card sensors may be provided to trigger camera activation so that the camera may distribute a single analog or digital snapshot of a card face and the camera does not have to send a steady stream of information. The card sensors (trigger sensors) may initiate or activate the image taking procedure by the camera by noting a leading edge of a card, a trailing edge of the card, a time frame when the sensor is blocked, a delayed activation (e.g., the card triggers an image-taking event to occur after a specified time has elapsed, such as the time expected for a card to move from trigger sensor to the camera focal plane). A leading edge sensor may trigger camera activity when the leading edge of the card has passed over the camera focal point, and the edge then triggers the

image capture event at a time when the symbols are over the camera focal point or focal plane. A trailing edge sensor would trigger the camera event when the trailing edge has passed over the sensor, which is at a measured distance that places the symbols over the camera focal plane.

5           Another description of a preferred automatic card shuffling device is provided. The device includes a microprocessor with memory for controlling the operation of the device. An in-feed compartment is provided for receiving cards to be randomized. In one example of the invention, the lower surface of the in-feed compartment is stationary. In another example of the invention, the lower surface is moveable in a vertical direction  
10 by means of an elevator. A card moving mechanism moves cards individually from the in-feed compartment into a card mixing compartment. The card mixing compartment includes a plurality of substantially vertical supports and an opening for the passage of cards from the in-feed compartment. In one form of the invention, the opening consists of a slot. The card mixing compartment also includes a moveable lower support surface  
15 and at least one stationary gripping arm, a lower edge of the gripping arm being proximate to the opening and the gripping arm, the opening allowing for the passage of cards into the card mixing compartment just below the gripped group of cards. The gripping arm is capable of suspending a card or a group of cards of a randomly determined size above the opening. In one example, the opening is a horizontal slot.

20           The device preferably includes an integrally formed automated calibration system. One function of the automated calibration system is to identify the vertical position of the elevator support platform relative to a lowermost gripping position of the grippers so that the stack of cards in the card mixing compartment can be separated at a precise location in the stack and so that a specific numbers of cards can be accurately lifted and specific  
25 card insert positions can be determined for insertion of cards into the randomizing stack of cards. Another function of the automated calibration system of the present invention is to automatically adjust the position of the grippers to compensate for different card length, width and/or card thicknesses. In one form of the invention, card values are read before or during card insertion. The value of the read card(s) may be stored in memory in

the shuffling/randomizing device or sent to a distal memory for storage and/or immediate use.

Another function of the preferred automated calibration system is to determine the number of incremental movements of the elevator stepper motors that corresponds to the thickness of each card. This information is then used to determine the precise location of the elevator in order to form each point of separation in the group of cards during shuffling.

An elevator is provided for raising and lowering the moveable card support surface. In operation, the vertical position of the elevator is randomly selected and the support surface is moved to the selected position. After the gripping arm grasps at least one side of the cards, the elevator lowers, suspending a group of cards, and creating a space (or point of insertion) beneath the gripping arm, wherein a single card is moved from the in-feed compartment into the space created, thereby randomizing the order of the cards.

A method of calibrating a shuffling machine prior to and during the randomization of a group of cards is described. The method comprises the steps of placing a group of cards to be randomized into a card in-feed tray and removing a calibration card from the in-feed tray, and placing the card in the card randomizing area, also known as the card collection area. The elevator and grippers are operated until a precise location of the bottommost card that can be gripped is identified. Either before or after this calibration process, the card width is measured, and the grippers are adjusted to put sufficient tension on the cards to suspend the entire group of cards to be shuffled.

According to the invention, cards are individually fed from the card in-feed tray and delivered into a card collection area. The card collection area has a moveable lower surface, and a stationary opening for receiving cards from the in-feed tray. The method includes elevating the moveable lower surface to a randomly determined height and grasping at least one edge of a group of cards in the card collection area at a point just above the stationary opening. The method further includes the steps of lowering the moveable lower surface to create an opening in a stack of cards formed on the lower



surface, the opening located just beneath a lowermost point where the cards are grasped and inserting a card removed from the in-feed tray into the opening.

5 A device capable of automatically calibrating is described that is capable of automatically making adjustments to process cards of different dimensions. The device includes a card in-feed tray, a card moving mechanism that transports cards from the in-feed tray into a card collection area; an elevator within the card collection area that raises and lowers the group of fed cards; a device capable of suspending all or part of the fed cards above the card feeder; and a microprocessor that selects the position in the stack where the next card is to be inserted, and instructs the device capable of suspending and  
10 the elevator to create a gap, and then instructing the card moving mechanism to insert the card.

#### **BRIEF DESCRIPTION OF THE FIGURES**

15 Figure 1 shows a perspective view of a prior art format for an automated gaming system.

Figure 2 shows an overhead view of a prior art format for an automated gaming system.

Figure 3 shows a side view of a prior art format for an automated gaming system.

20 Figure 4 shows a block schematic of the electronic configuration of a prior art animated gaming system.

Figure 5 shows a perspective view of a format for an automated gaming system according to the present invention.

Figure 6 shows a schematic view of gaming engine (dealer) useful in the practice of the present invention.

25 Figure 7 shows a schematic of a player station useful in the practice of the present invention.

Figure 8 shows a schematic of one preferred embodiment of a game display useful in the practice of the present invention.

Figure 9 shows perspective cutaway view of one embodiment of a shuffling apparatus with a card-reading capability.

Figure 10 shows a side plan view of one embodiment of a shuffling apparatus with card-reading capability.

5           Figure 11 shows a perspective view of a card feed mechanism of a shuffling apparatus of the present invention.

Figure 12 shows a front cut-away view of the feed roller mechanism.

Figure 13 shows side cut-away view of a pair of gripping arms.

10           Figure 14 shows a perspective view of a second embodiment of the shuffling apparatus.

Figure 15 shows a side elevational view of a second embodiment of a shuffling apparatus.

Figure 16 shows a perspective view of another preferred embodiment of the shuffler of the present invention.

15           Figure 17 shows a side elevational view of another shuffler of the present invention.

Figure 18 shows a top cut-away view of another shuffler of the present invention.

### **DETAILED DESCRIPTION OF THE INVENTION**

20           It should be first understood that in the description of the practices, methods, components, subcomponents and apparatus of the present invention, the examples and specific materials identified are merely exemplary and are not intended to be taken as limits in the practice of the invention. For example, any computer language may be used, any operating system may be used, any commercial or specially designed hardware that  
25           can perform the identified functions and provides the described properties can be used, even if the specific component described is or is not a preferred embodiment of the invention. Although a preferred card randomization or card shuffling device is described in detail, the automated gaming system of the invention may be used with any physical system that provides a randomized or shuffled physical set of cards that is read and the

order of the shuffled or randomized cards provided into an electronic file. The electronic file is not desirably used more than once, just as a shuffled deck is not collected and reused at a standard casino table card game. The electronic data of the randomized set of physical cards is used as a virtual replacement for the physical cards in the play of the automated game, and the virtual deck is treated much the same as a real deck. A virtual cut is made in the virtual deck (the data of the order of the physical deck), the game is played (e.g., with poker the cards are dealt, additional cards dealt, and at the conclusion of a single hand, the deck is usually reshuffled; and with blackjack, hands are repeatedly played until the 'cut' card is reached in the play of a hand, and then that hand is completed, all cards collected, and the set of cards are reshuffled.

A gaming system according to the present invention comprises a table and a dealer "virtual" video display system positioned for view by players seated at the table. The table may seat at least two players up to the amount of players that can be configured about the table and have a view of the dealer video display system. Typically each gaming system will have at least four player available positions, with space determinations considered as to whether there would be 4, 5, 6 or 7 player positions. It is possible to have a completely circular dealer display (e.g., holographic display in a cylindrical centerpiece) and have players distributed around the entire periphery, but this is too dissimilar to standard play arrangements and could slow the game down, as play should approximate that of a live game, with players playing in sequence. A surface of the table will have a generally continuous display surface for showing players' hands (and possibly dealer hands) and, where there are touch screen player controls, for displaying the player touch screen controls. A majority of the table surface comprises a video monitor in one example of the invention. Where there are no touch screen controls, the continuity of the surface may be interrupted by inserted player control panels. The use of a continuous (except for possible interruption by the above indicated panels) display surface offers some significant advantages in simulating or recreating a standard card table surface. Cards may be readily viewed by other players at a blackjack table, which is standard in table games. Individual monitors, especially where slanted towards

the individual players make such table-wide card reading difficult. The use of the full screen (continuous) display also allows for better animation to be provided, such as displaying virtual images of cards moving to the player and “virtual” chips being placed on the table when wagers are indicated. For purposes of this disclosure, the term

5 “virtual” means a graphical video representation of a real object or person, such as a dealer, cards and chips, for example.

The individual player positions have a separate intelligence at each player position that accepts player input and communicates directly with a game engine (main game computer or processor). The intelligence is preferably an intelligent board that can

10 process information. For purposes of this disclosure the term “intelligent” refers to the ability to execute code, either provided in the form of software or hardware circuits. Such processing may at least comprise some of signal converting (e.g., signals from player card readers, credit deposit, currency readers, coin readers, touch screen signals, control panel signals) into a signal that can be included in an information packet and

15 interpreted by the main game computer when the signal is sent. Communication between the intelligence at each player position is direct to the main game computer and may be by self-initiated signal sending, sequenced polling by the main game computer (e.g., each position communicates directly to the main game computer in turn), timed

20 communication, or any other order of communication that is direct between the intelligence and the main game computer. Communication can also occur between the casino computer and main game computer or between the casino computer and player station computer or both. In one example of the invention, there is essentially a single main game computer that contains video display controls and programs for both the dealer display and the table top display, audio controls and programs, game rules

25 (including storage of multiple games if intended to be available on the machine), random number generator, graphic images, game sequence controls, security systems, wager accounting programs, external signaling and audit functions, and the like. In other forms of the invention, the above functions are divided between a main processor and one or more additional processors. The intelligence at each player position speeds up the

performance of all aspects of the game by being able to communicate directly with the main game computer and being able to process information at the player position rather than merely forwarding the information in raw form to the main game computer. Processing player information at player positions frees up resources for use by the main processor or processors.

A card game system may also include suitable data and control processing subsystem that is largely contained within a main control module supported beneath the tabletop. The control and data processing subsystem includes a suitable power supply for converting alternating current from the power main as controlled by a main power switch. The power supply transforms the alternating line current to a suitable voltage and to a direct current supply. Power is supplied to a power distribution and sensor/activity electronics control circuit. Commercially available power switching and control circuits may be provided in the form of a circuit board which is detachable, and plugs into a board receptacle of a computer mother board or an expansion slot board receptacle. A main game controller mother board may include a central microprocessor and related components well-known in the industry as computers using Intel brand Pentium microprocessors and related memory or intelligence from any other manufacturing source. A variety of different configurations and types of memory devices can be connected to the motherboard as is well known in the art. Of particular interest is the inclusion of two flat panel display control boards connected in expansion slots of the motherboard. Display control boards are each capable of controlling the images displayed for the dealer video display and for each of the player position display areas on the continuous display screen on the table and other operational parameters of the video displays used in the gaming system. More specifically, the display control boards are connected to player bet interfaces circuits for the player stations. This arrangement also allows the display control boards to provide necessary image display data to the display electronic drive circuits associated with the dealing event program displays and the dealer display.

The motherboard and/or each player station board also include a serial port that allows stored data to be downloaded from the motherboard to a central casino computer or other additional storage device. This allows card game action data to be analyzed in various ways using added detail, or by providing integration with data from multiple  
5 tables so that cheating schemes can be identified and eliminated, and player tracking can be maintained. Player performance and/or skill can be tracked at one table or as a compilation from gaming at multiple tables, as by using Bloodhound™ security software marketed by Shuffle Master, Inc., which may be incorporated into this automated gaming system. Additionally, player hand analysis can be performed. The motherboard and/or  
10 player station boards may also have a keyboard connection port that can be used to connect a larger format keyboard to the system to facilitate programming and servicing of the system.

Although the preferred system shown does not require features illustrated for receiving automated player identification information, such features can alternatively be  
15 provided. Card readers such as used with credit cards, or other identification code reading devices can be added in the system to the player stations, for example, to allow or require player identification in connection with play of the card game and associated recording of game action by the processor. Such a user identification interface can be implemented in the form of a variety of magnetic card readers commercially available for reading a user-  
20 specific identification information. The user-specific information can be provided on specially constructed magnetic cards issued by a casino, or magnetically coded credit cards or debit cards frequently used with national credit organizations such as VISA, MASTERCARD, AMERICAN EXPRESS, casino player card registry, banks and other institutions.

25 Alternatively, it is possible to use so-called smart cards to provide added processing or data storage functions in addition to mere identification data. For example, the user identification could include coding for available credit amounts purchased from a casino. As further example, the identification card or other user-specific instrument may include specially coded data indicating security information such as would allow

accessing or identifying stored security information which must be confirmed by the user after scanning the user identification card through a card reader. Such security information might include such things as file access numbers which allow the central processor or player station processor to access a stored security clearance code which the user must indicate using input options provided on displays using touch screen displays. A still further possibility is to have participant identification using a fingerprint image, eye blood vessel image reader, or other suitable biological information to confirm identity of the user that can be built into the table. Still further it is possible to provide such participant identification information by having the pit personnel manually code in the information in response to the player indicating his or her code name or real name. Such additional identification could also be used to confirm credit use of a smart card or transponder. All or part of the functions dedicated to a particular player station are controlled by the player station intelligence in one form of the invention. Additionally, each player station intelligence may be in communication with a casino accounting system.

It should also be understood that the continuous screen can alternatively be provided with suitable display cowlings or covers that can be used to shield display of card images from viewing by anyone other than the player in games where that is desirable. This shielding can also be effected by having light-orientation elements in the panel, and some of these light-orientation elements are electronically controllable. In this manner, the processor can allow general viewing of cards in games where that is desirable or tolerated, and then alter the screen where desired. These types of features can be provided by nanometer, micrometer or other small particulate or flake elements within a panel on the viewing area that are reoriented by signals from the processor. Alternatively, liquid crystal or photochromic displays can be used to create a screening effect that would allow only viewers at specific angles of view from the screen area to view the images of cards. Such an alternative construction may be desired in systems designed for card games different from blackjack, where some or all of the player or dealer cards are not presented for viewing by other participants or onlookers. Such

display covers or cowlings can be in various shapes and configurations as needed to prevent viewing access. It may alternatively be acceptable to use a player-controlled switch that allows the display to be momentarily viewed and then turned off. The display can be shielded using a cover or merely by using the player's hands. Still further it is possible to use a touch screen display that would be controlled by touch to turn on and turn off. Similar shielding can be used to prevent others from viewing the display.

A review of the figures will assist in a further understanding of the invention.

Figure 1 shows a fully automated gaming table 1 of the prior art, as disclosed in US Patent Application 2003/0199316. The system 1 comprises a vertical upright display cabinet 2 and a player bank or station cluster arrangement 3. The vertical display cabinet 2 has a viewing screen 7 on which images of the virtual dealer are displayed. The top 8 of the player bank arrangement 3 has individual monitor screens 10 for each player position, as well as tabletop inserted coin acceptors 11, and player controls 12 and 13. There is a separate and larger dealer's hand screen 9 on which dealer cards are displayed in a format large enough for all players to view. Speakers 16a and 16b are provided for sound transmission and decorative lights 14 are provided. Figure 2 shows an overhead view of the same prior art automated gaming system 1 with the viewing screen 7 shown more clearly as a CRT monitor. It can also be seen that each player position has to form an arc cut into the semicircular player seating area 18. Figure 3 shows a side view of the same prior art automated gaming system of Figures 1 and 2 where the orientation of the three different types of CRT monitors 7, 9 and 10 are shown.

Figure 4 shows the schematic circuitry of a prior art automated system as disclosed in 2003/0199316. Figure 4 is a block diagram of processing circuitry in the game device of Figure 1. The game device housing comprises a CPU block 20 for controlling the whole device, a picture block 21 for controlling the game screen display, a sound block 22 for producing effect sounds and the like, and a subsystem 21A for reading out CD-ROM.

The CPU block 20 comprises an SCU (System Control Unit) 200, a main CPU 201, RAM 202, RAM 203, a sub-CPU 204, and a CPU bus 205. The main CPU 201



contains a math function similar to a DSP (Digital Signal Processing) so that application software can be executed rapidly.

5 The RAM **202** is used as the work area for the main CPU **201**. The RAM **203** stores the initialization program used for the initialization process. The SCU **200** controls the busses **205**, **206** and **207** so that data can be exchanged smoothly among the VEPs **220** and **230**, the DSP **241**, and other components.

10 The SCU **200** contains a DMA controller, allowing data (polygon data) for character(s) in the game to be transferred to the VRAM in the picture block **21**. This allows the game machine or other application software to be executed rapidly. The sub-CPU **204** is termed an SMPC (System Manager & Peripheral Control). Its functions include collecting sound recognition signals from the sound recognition circuit or image recognition signals from the image recognition circuit in response to requests from the main CPU **201**. On the basis of sound recognition signals or image recognition signals provided by the sub-CPU **204**, the main CPU **201** controls changes in the expression of  
15 the character(s) appearing on the game screen, or performs image control pertaining to game development, for example. The picture block **21** comprises a first VPD (Video Display Processor) **220** for rendering TV game polygon data characters and polygon screens overlaid on the background image, and a second VDP **230** for rendering scrolling background screens, performing image synthesis of polygon image data and scrolling  
20 image data based on priority (image priority order), performing clipping, and the like. The first VPD **220** houses a system register **220a**, and is connected to the VRAM (DRAM) **221** and to two frame buffers **222** and **223**. Data for rendering the polygons used to represent TV game characters and the like is sent to the first VPD **220** through the main CPU **20**, and the rendering data written to the VRAM **221** is rendered in the form of  
25 16- or 8-bit pixels to the rendering frame buffer **222** (or **223**). The data in the rendered frame buffer **222** (or **223**) is sent to the second VDP **230** during display mode. In this way, buffers **222** and **223** are used as frame buffers, providing a double buffer design for switching between rendering and display for each individual frame. Regarding information for controlling rendering, the first VPD **220** controls rendering and display in



accordance with the instructions established in the system register **220a** of the first VPD **220** by the main CPU **201** via the SCU **200**.

The second VDP **230** houses a register **230a** and color RAM **230b**, and is connected to the VRAM **231**. The second VDP **230** is connected via the bus **207** to the first VPD **220** and the SCU **200**, and is connected to picture output terminals Voa through Vog through memories **232a** through **232g** and encoders **260a** through **260g**. The picture output terminals Voa through Vog are connected through cables to the display **7** and the satellite displays **10** (Figure 1).

Scrolling screen data for the second VDP **230** is defined in the VRAM **231** and the color RAM **230b** by the CPU **201** through the SCU **200**. Information for controlling image display is similarly defined in the second VDP **230**. Data defined in the VRAM **231** is read out in accordance with the contents established in the register **230a** by the second VDP **230**, and serves as image data for the scrolling screens that portray the background for the character(s). Image data for each scrolling screen and image data of texture-mapped polygon data sent from the first VPD **220** is assigned display priority (priority) in accordance with the settings in the register **230a**, and the final image screen data is synthesized.

Where the display image data is in palette format, the second VDP **230** reads out the color data defined in the color RAM **230b** in accordance with the values thereof, and produces the display color data. Color data is produced for each display **7** and **9** and for each satellite display **10**. Where display image data is in RGB format, the display image data is used as-is as display color data. The display color data is temporarily stored in memories **232a-232f** and is then output to the encoders **260a-260f**. The encoders **260a-260f** produce picture signals by adding synchronizing signals to the image data, which is then sent via the picture output terminals Voa through Vog to the display **7** and the satellite displays **10**. In this way, the images required to conduct an interactive game are displayed on the screens of the display **7** and the satellite displays **10**.

The sound block **22** comprises a DSP **240** for performing sound synthesis using PCM format or FM format, and a CPU **241** for controlling the DSP **240**. Sound data

generated by the DSP **240** is converted into 2-channel sound signals by a D/A converter **270** and is then presented to audio output terminals Ao via interface **271**. These audio output terminals Ao are connected to the input terminals of an audio amplification circuit. Thus, the sound signals presented to the audio output terminals Ao are input to the audio amplification circuit (not shown). Sound signals amplified by the audio amplification circuit drive the speakers **16a** and **16b**. The subsystem **23** comprises a CD-ROM drive **19b**, a CD-I/F **280**, and CPU **281**, an MPEG-AUDIO section **282**, and an MPEG-PICTURE section **283**. The subsystem **23** has the function of reading application software provided in the form of a CD-ROM and reproducing the animation. The CD-ROM drive **19b** reads out data from CD-ROM. The CPU **281** controls the CD-ROM drive **19b** and performs error correction on the data read out by it. Data read from the CD-ROM is sent via the CD-I/F **280**, bus **206**, and SCU **200** to the main CPU **201** that uses it as the application software. The MPEG-AUDIO section **282** and the MPEG-PICTURE section **283** are used to expand data that has been compressed in MPEG (Motion Picture Expert Group) format. By using the MPEG-AUDIO section **282** and the MPEG-PICTURE section **283** to expand data that has been compressed in MPEG format, it is possible to reproduce motion picture. It should be noted herein that there are distinct processor for the CPU block, video block, sound block, CD-ROM drive and Memory with their independent PCU's. This requires significant computing power and still has dumb (no intelligence) player input components.

Figure 5 shows an example of an automated table system **101** of the present invention. The system **101** has an upright dealer display cabinet **102** with a top **104** and the dealer viewing screen **107** which may be any form of display screen such as a CRT, plasma screen, liquid crystal screen, LED screen or the like. The player bank arrangement **103** has a continuous display screen **109** on which images of cards being dealt **105**, dealer's cards **108**, bets wagered **111** and touch screen player input functions **110** are displayed. Other player input functions may be provided on a panel **106** which might accept currency, coins, tokens, identification cards, player tracking cards, ticket in/ticket out acceptance, and the like.

Figure 6 shows an electronic/processor schematic for a MultiPlayer Platform (MPP) gaming system according to the present invention. The MPP Game engine (dealer) comprises a Heber Pluto 5 casino game board **290** (Motorola 68340 board) operating off the PC Platform Pentium 4 MPP Game Display processor **202**. The game display processor operates on a Windows XP platform. The respective subcomponents on the Pentium 4 processor are labeled to show the apportionment of activity on the motherboard and the component parts added to the board. As is shown, the game engine has an Uninterruptible Power Supply **204**. The game display processor directs activity on the Speakers, directs activities onto the MPP Game Service panel, and the Plasma Monitor Card Table display. It is important to note that all communications are direct from the game display processor, freeing up resources available to the game engine processor.

Figure 7 shows the electronic/processing schematics of the MPP Player Station Intelligence board (Heber Pluto 5 Casino, Motorola 68340), each of which player stations (one for each player position) are in direct connection to the MPP Game Engine (Dealer), which is in turn directly connected to the PC Platform. (not shown in this Figure). Each Intelligence board **300** receives information for all player input systems specific to that player station, such as the shown Coin Acceptor **310**, Coin Hopper **312**, Bill Validator **314**, Ticket Printer **316**, Touch Screen **317** and/or Display Button Panel **318**, Dual Wire Ticket-in-Ticket-Out Printing and SAS System **320** (SAS is one exemplary standard communications protocol used by a number of casinos central computer systems.) A significant benefit resides in the use of the independent Intelligence boards **305** at each player position being in direct communication with the MPP Game Engine **300**, as opposed to each individual player position button panel being dead or inactive until authorized by the main game processor, as previous automated gaming systems were constructed.

The present invention is also an improvement in providing a system with not only the intelligence at each player position, but also in redistributing processing capability for functions among various processing components within the gaming system. In one

architectural format, all functions of the gaming engine, except for the player localized intelligence functions and central computer communication functions, are consolidated into a single PC (e.g., the Pentium 4 shown in the Figures). This would include all game functions, player video functions, dealer video functions, dealer audio functions, security, currency and debit functions, alarm functions, lighting functions, and all other peripherals on the system, except for the localized player functions. In this system, the main game processor would talk directly with the player intelligent boards, preferably in the same novel communication format described below.

The exemplary system illustrated in Figures 6, 7 and 8, includes a dealer engine processor 306, intermediate the main game PC 300 and the Player intelligent boards 305. Both systems are a distinct improvement over the prior art, but with the higher power available for PC's, and with the ease of programming a PC as opposed to an embedded system, the consolidation of the game functions and the ability of the main game engine to communicate with each of the player positions is enabled. As shown in Figure 8, the Game display processor 300 is preferably a Pentium 4 PC and is separate from the main processor 306. With the player intelligent boards 305, the main game PC can receive packets of information from each player station as events occur rather than having to poll each player position on a regular basis 100 times to gain the specific information for each player input that may be made.

A description of the Heber Board, (an exemplary board that can be used as a player station processor 305 and/or game engine processor 306) a commercially available intelligent processing board is as follows: the Heber Board is known for its reliability and flexibility, especially for the Pluto 5 family of gaming products. The Pluto 5 is the controller of choice for the global gaming industry. Flexibility comes from a set of features built into the Pluto 5 (Casino) controller, and from the choice of optional add-on boards that can be used to adapt the Pluto family to best suit individual applications. In the area of interfacing, there are three distinct boards, each of which serves a particular function in helping the Pluto 5 to connect with the world outside:

**RS485 board**

RS485 is an industrial-grade board for linking multiple systems in unforgiving circumstances for centralized information gathering. The Heber RS485 board is fully opto-isolated to provide complete circuit safety when used within 'electrically noisy' environments. The RS485 board uses a single RS232 connection to the Pluto 5 board and all necessary power is also derived through this link. Two header connectors may be provided for the RS485 channel to allow daisy chain connections between multiple systems.

**HII/ccTalk board**

This board specializes in communicating with industry standard note/coin acceptors and payout hoppers. Equipped with dual communication channels, each port is configurable to use either the HII format to connect with Mars® coin/note acceptors or the ccTalk format for Money Controls® hoppers. Both channels are controlled via a single RS232 connection to the Pluto 5 board and all necessary power is also derived through this link. The Heber FastTrack package contains modular library functions for passing information via these channels.

**Four channel relay board**

The relay board allows control of medium- to high-level loads such as solenoids, without risk of damage or interference to the Pluto 5 circuitry. Four power-switching channels are available with absolute isolation from the Pluto 5 control signals. Each relay is capable of switching direct or alternating currents of up to 7A at a maximum voltage of 250V.

Like the Pluto 5 board itself, its modular options have been used extensively so that their designs are fully developed and entirely stable. The options that are specified are consistently provided in mass quantities. As with all Pluto products, programming for the modular options is straightforward. This is enhanced with the use of the Pluto 5 Enhanced Development Kit and also the FastTrack package. Between them, these kits

contain all of the low level and high level programming tools and library functions.

These systems can be provided through a Pluto 5 Enhanced Development Kit datasheet

80-15353-7

Heber Limited, Belvedere Mill, Chalford, Stroud, Gloucestershire, GL6 8NT, UK

5 Tel: +44 (0) 1453 886000 Fax: +44 (0) 1453 885013 www.heber.co.uk

Specifications for the various boards are identified below.

### **RS485 interface**

#### **Host interface**

- 10
- RS232 connection to Pluto 5/Pluto 5 Casino
  - All power provided via RS232 link from host system

#### **Communication port**

- Dual four-way Molex 0.1" KK headers for daisy chaining purposes

15

#### **Dimensions**

- 80 x 61mm (3.14 x 2.4")

#### **Part number**

- Opto-isolated RS485 board
- 01-14536-2

20

#### **HII/ccTalk interface**

#### **Host interface**

- RS232 connection to Pluto 5/Pluto 5 Casino
- All power provided via RS232 link from host system

#### **Communication port**

- 25
- Single or dual 10 way header connectors

#### **Dimensions**

- 101.6 x 69.85mm (4 x 2.8")

#### **Part number**

- Dual channel HII/ccTalk board

01-16171-2

#### **Four channel relay board**

##### **Host interface**

- Connection to Pluto 5/Pluto 5 Casino via ribbon cable
- 5 using four standard output lines
- All power provided via ribbon cable link from host system

##### **Switching capabilities**

- Up to 250V AC or DC @ 7A maximum per channel

##### **Dimensions**

- 10 • 80 x 61mm (3.14 x 2.4")

##### **Part number**

- Four channel relay board

01-15275-1

80-16949-1

- 15 One proposed hardware configuration uses a "satellite" intelligent processor **305** at each player position. The player station satellite processor is substantially the same as the primary game engine processor **306**, a Heber Pluto 5 Casino board. The satellite processors receive instruction from the primary game engine but then handle the communications with player station peripherals and casino computer systems
- 20 independently. Each satellite processor communicates with only the peripherals at the same player station. Thus each player station has a dedicated satellite processor communicating with only the peripherals at the same player station and with the casino's central computer system. The peripherals are, but not limited to: Slot accounting Systems, Bill Validator, Ticket Printer, Coin Acceptor, Coin Hopper, Meters, Button
- 25 panel or LCD touch screen and various doors and keys.

The satellite processors run proprietary software to enable functionality. The player station software is comprised of two modules, the first being an OS similar to the game engine Operating System and the second being station software that handles peripheral communications. The software may be installed on EPROM's or other storage



media for each satellite processor. The primary method of communication between the satellite processors and the primary game engine is via serial connectivity and the previously described protocol. In one example, information packets are prepared by the satellite processors and are sent to the game engine processor on the happening of an event.

The proposed game engine provides communication to the player stations to set the game state, activate buttons and receive button and meter information for each player station. Communication is via a serial connection to each of the stations. The new protocol for communication between the game engine, game display and player stations is an event driven packet-for-packet bi-directional protocol with Cyclic Redundancy Check (CRC) verification. This is distinguished from the Sega system that used continuous polling. This communication method frees up resources in the same engine processor because the processor no longer needs to poll the satellites continuously or periodically.

Format of Command Packet

STX	SEQ	DATA LENGTH	DATA	CRC-16	ETX
1	1	3	3-999	5	1

Format of Response Packet

STX	SEQ	DSP	PRV	ETX
1	1	1	1	1

Format of Synchronization Response Packet

STX	MTS	MRS	ETX
1	1	1	1

Legend For Figures

STX	Start of Packet Character
SEQ	Sequence # (Cycles from '0' thru '9')
LEN	Length of Data Area ('003' thru '999')
DATA	ASCII Data Fields Separated with ' ' Character
CRC	CRC-16 Value ('0000' thru '65535') Cyclic Redundancy Check
ETX	End of Packet Character

DSP	Disposition Code ('A' ACK, 'N' NAK, or 'I' Invalid Sequence)
PRV	Sequence Number of Last ACK'ed Packet (0 thru 9)
MTS	Main's Current Transmit Sequence Number
MRS	Main's Current Receive Sequence Number

5 The Command Packet and Response Packet are used during primary game communications. The protocol uses redundant acknowledgement. For example: The packet is initially acknowledged when first received by the recipient. The same recipient will resend another acknowledgement in the next communication. This second acknowledgement is the 'PRV' data in the response packet.

10 The communications between the Game Engine and the Player Stations is preferably a transaction-based protocol. Either device can start a transaction, which is why it is essential that there be an intelligent board at each player position. All packets of information may be sent in any acceptable format, with ASCII format preferred as a matter of designer choice. All command packets usually contain a sequence number that is incremented after each successful packet exchange. The Game Engine and the Player Station use sequence numbers that are independent of each other. The sequence number keeps the communications in synchronization. This synchronization method is described later.

15 The command packet is used to send various commands such as Inputs, Lamps, Doors, Errors, Chirp, Game Results, player input, coin acceptance, player identification, credit acceptance, wagers, etc... The command packet format may be, by way of a non-limiting example,:

20 <STX><Sequence number><Data Length><Data><CRC-16><ETX>

The data format within the command packet may be:

<Address><Command><Field 1>|<Field 2>|<Field n>|

The response packet format may be:

<STX><Sequence number><Disposition><Previous ACK><ETX>

25 The sync request packet format may be:

<SYN>

The sync response packet format may be:

<STX><Mains Current Transmission Sequence><Mains Current Receive  
Sequence><ETX>

- 5           A major strength of the protocol is its resilience of the Game Protocol and its ability to free up resources within the game engine. Those resources can in turn be used to provide more intricate games, and multi-media affects.

#### **Synchronization Method:**

- 10           The satellite and host must become synchronized in order to provide for reliable communications using packet numbers. To facilitate this, a novel protocol synchronization method that is used. Upon applying power to the satellite, or after a communications failure, the satellite automatically enters into synchronization mode. In the synchronization mode the satellite sends out the ASCII SYN (0x16) character about  
15           every second. It is expecting a special response packet containing transmit and receive packet sequence numbers to be used from that point on. After receiving the special response packet, the sequence numbers are used as-is, and not incremented until the a successful packet exchange. After communications is synchronized, the sequence numbers are incremented after each packet is successfully sent or received.

- 20           As was noted before, the main game processor may contain information, data, programming and other necessary functions to enable the play of multiple games off the same machine. For example, the main game engine may have rules and commands that will enable play of Blackjack, Let It Ride® poker, Three-Card™ poker, Four-Card™ poker, Caribbean Stud® poker, Spanish 21® blackjack, baccarat, Pai Gow poker, and  
25           other card games. The system may be controlled so that different games may be played at different times on command of the casino or players.

          All of the apparatus, devices and methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure. While the apparatus, devices and methods of this invention have been described in terms

of both generic descriptions and preferred embodiments, it will be apparent to those skilled in the art that variations may be applied to the apparatus, devices and methods described herein without departing from the concept and scope of the invention. More specifically, it will be apparent that certain elements, components, steps, and sequences that are functionally related to the preferred embodiments may be substituted for the elements, components, steps, and sequences described and/or claimed herein while the same or similar results would be achieved. All such similar substitutions and modifications apparent to those skilled in the art are deemed to be within the scope and concept of the invention as defined by the appended claims.

A preferred automatic shuffling device is described for forming a randomly arranged set of playing cards is described below. One embodiment of the device of the present invention shuffles between one and eight or more decks of cards (standard deck or decks of 52 cards each or 52 cards plus one or two jokers) and is particularly well suited for providing randomized batches of cards for games such as single deck blackjack, poker, double deck blackjack, and multi deck blackjack, for example. Another embodiment of the invention is suitable for shuffling either a single deck or two decks of cards.

The device includes a top surface and a bottom surface, a card receiving area for receiving an initial set of playing cards to be randomized and a randomizing system for randomizing an order of the initial set of playing cards. The device further includes a card collection area and a card collection surface within the card collection area for receiving randomized playing cards, the collection surface receiving cards in a manner such that that all cards are inserted into the collection area below the top surface of the device. An elevator is provided for raising and lowering the collection surface during shuffling, and elevating the shuffled (alternatively referred to as 'randomized') group of cards at least as high as the top surface of the device after shuffling (that is, the lowest card in the shuffled group of cards is raised to a level where it may be easily and manually removed from that level, preferably with the lowest card being level with or above a plane defining the top surface of the device). A card suspension mechanism such

as a pair of oppositely spaced grippers grasp some or all of the cards on the card collection surface. The elevator is lowered, creating a gap or point of insertion for the next card to be fed. Once shuffling is complete, the cards are elevated so that they can be removed by the attendant or dealer and used for dealing. While cards are being dealt, a second group of cards is being randomized. The use of two groups of cards eliminates any waiting on the part of the dealer or the casino patrons between rounds of play.

For example, because the device is able to transport cards rapidly and read card values (e.g., suit and rank, or special values such as wild cards, jokers, etc.), the device may be used as a deck verification system as well as card shuffler/randomizer. There are a number of modes by which this can be practiced. The least complicated, but less preferred method is to have the device shuffle or randomize a complete set of cards and have each and all of the cards of the set read and compared to the expected content (e.g., in a look-up table for a regular or special deck, a number of regular or special decks, and the like). By comparing the read values to the stored values, the set of cards can be verified. The stored values can be provided from a previous reading of the set of cards (e.g., during an earlier shuffle/randomization) or from a separate reading of the cards from a separate device such as a card reading tray (e.g., U.S. Patent No. 6,460,848), dealing shoe (e.g., U.S. Patent Nos. 6,403,908; 5,605,334; 6,039,650; and 5,722,893). Comparison to the earlier stored values can be performed in the microprocessor in the shuffling device, or the information can be out loaded from a port to a distal microprocessor (e.g., central computer) that also has the stored values, or at both locations.

A more preferred method would be to actuate a special mode within the shuffling device wherein cards would be removed one at a time from the card in-feed tray of the shuffler (possibly in an order that had already been read from another device or by the shuffling device in an earlier reading of the cards), and there is a special support plate that can receive the entire set of cards without having to create openings for card insertion. For example, the grippers could be deactivated and all cards could be transferred in order onto the support plate. This can speed up the card set validation as

compared to an actual shuffling or randomization process. In this fast verification mode, the camera may operate with single, quick shot images of each card or provide the data in a steady stream, since there would be less data (because of the faster movement of the cards and set of cards) as compared to a shuffling procedure. The data stream in the fast  
5 verification mode would not be as excessive as in a shuffling mode. Cards could be read when stationary or in motion, in the card in-feed tray or during transfer onto the support plate.

There are a number of special features that combine to make the present invention a significant advance over previously described card shuffling systems and card shuffling  
10 processes. Among individual features that constitute an advance, alone or in combination with other features include a system for automatically calibrating and inspecting the position and performance of an elevator for moving the final set of randomized cards upwardly so that the stack is accessible to the dealer or attendant. In one example of the invention, the elevator elevates the group of cards to the playing table surface. The same  
15 elevator advantageously assists in accomplishing shuffling within the card collection and/or mixing area.

The card collection area in another example of the invention has a plurality of vertical supports (e.g., 2 or 3 walls, or four walls with an manually accessible area where the lowest card may be gripped), and a moveable lower surface. The elevator supports  
20 this moveable lower surface (also referred to herein as the collection surface) and causes the surface to move back and fourth (relatively up and down) in a substantially vertical direction. One function of the movement of the elevator (during the shuffling or randomizing sequence) is to position a stack of cards within the card collection area so that a card or cards can be inserted into the stack in a specifically selected or randomly  
25 selected precise position within the stack to randomize, organize or arrange the cards in a desired order, such as "pack order" for inspection (particularly after reading the suit and rank of cards) or to randomize the cards into a shuffled set of cards that can be dealt to players. The insertion of cards may be performed in a number of ways, such as by lifting or by dropping a section of the stack and inserting one or more (and preferably just one)

cards into the gap, by positioning the stack near a card insertion position and inserting one or more cards into the stack, or inserting a wedge-like element or blade between cards in the stack to elevate a portion of the stack where card(s) may be inserted (as described in Breeding et al., U.S. Patent No. 5,695,189 (assigned to Shuffle Master, Inc.), which is incorporated herein by reference.

In a preferred mode of operation of the shuffler of the present invention, a picking, gripping or separating system is provided for suspending segments of the stack of cards present in the card collection area, creating an opening in the group of cards, so that a card or cards can be inserted in specific locations relative to other cards in the deck. A variant of this system is described in pending U.S. Patent Application, U.S. Serial No. 09/967,502, filed January 8, 2002 (assigned to Shuffle Master, Inc.), now U.S. Patent 6,651,981. According to that invention, the picking, gripping or card suspending system is fixed in the vertical direction. By randomly selecting a vertical position for the moveable base of the card receiving area prior to picking, the location of an opening created in the stack of cards by gripping a portion of the cards and lowering another portion of the cards below the gripping area is varied, with random insertion of cards into these openings causing randomization of the cards.

Offset rollers are the preferred mechanism provided for moving the individual cards from the card receiving area into the card collection area, although air jets, belts, injection plates, injection blades and the like may also be used for moving individual cards or small numbers of cards (e.g., 1, 2, 3, 4 or 5 cards) into the card receiving area. A stack stabilizing area is provided in one example of the invention for receiving an elevated final set of cards lifted from the card collection area. This stack stabilization area should be positioned or positionable above the top of the device or should begin at the top of the device. In another example of the invention, the elevator itself is equipped with a stack stabilizing structure that is lowered into the inside of the shuffler prior to the randomization of cards. In one embodiment later described in greater detail, a delivery or elevator platform provides its own card stabilization area or in conjunction with an elevator drive arm provides such a card stabilization area. A single belt drive is provided

in one example of the invention for driving two spaced apart and opposed vertically disposed picking elements in a card segment picking system. The picking elements are vertically disposed along the path of movement of the collection area of cards in the collection shaft, and are horizontally disposed or opposed with respect to each other. A  
5 microprocessor is provided, but it no longer must employ a random number generator to identify or create an intended (including random) distribution of an initial set of cards in the card receiving area at the conclusion of shuffling. The random number generating function and card set generating functions may be left in the device, even though with the associated physical card shuffler with reader, this function is not needed. The shuffler is  
10 communicatively coupled to the main game computer to provide the information on the order of cards in each new randomized set of cards that is created. This can be through an available port on the PC, main game processor, dealer processor and the like. The microprocessor executes movement of elements in the shuffling apparatus, including the opposed picking elements and the elevator to effect placement of each card into spaces in  
15 the stack created by the shuffling apparatus, and a randomized set of cards is rapidly formed. That microprocessor (in the shuffling device or in an associated game device) or a separate or parallel microprocessor is used to direct the calibration steps. In one example of the invention, the picking elements move horizontally to grasp opposite edges of a group of cards. Other suspension systems are contemplated, such as inserting a flat  
20 member between the cards above the point of separation.

The individual and combined elements of the invention will be described in detail, after a more general description of the invention is provided. A first general description of the invention is a device for forming a random set of playing cards comprising: a top surface and a bottom surface of said device; a receiving area for an initial set of playing  
25 cards; a randomizing system for randomizing the order of the initial set of playing cards; a collection surface in a card collection area for receiving the randomized playing cards; an elevator for raising the collection surface within the card collection area; and at least one card supporting element within the card collection area that is horizontally fixed with respect to the vertical. The card supporting element will support and suspend a precise



number of a randomly determined number of cards within the card collection area to create a gap or space within the stack of cards within the collection area that is a card insertion point. The card insertion point or gap is created in the card collection area just below the lowermost portion of the card supporting element or elements. Each time the card supporting elements support a next group of cards, and the elevator beneath the card collection area is lowered, lowering a remaining group of cards and creating a gap.

The device may have one or more card supporting elements comprising at least one vertically disposed element on at least one side of the card collection area. In the alternative, the card supporting elements include at least two opposed supporting elements such as flexible or soft (e.g., polymeric, elastomer, rubber or rubber-coated) gripping elements that can move inwardly along a horizontal plane within the card collection area to contact and support the opposite edges of at least a portion of the stack, or substack or group of cards. Or, a horizontally disposed flat member such as a pair of forks or a flat plate may be inserted between the cards, so that when the elevator is lowered, an insertion point or gap is formed. The substack may be defined as all cards within the collection area at or above a randomly selected card or position in the stack within the card collection area. The device desirably has a microprocessor communicatively connected to the device. The microprocessor in one example of the invention is programmed to determine a distance that the card supporting surface must be vertically moved in order to position each card in the desired order within the stack. In one example of the invention, cards fed into the card collection area may be placed anywhere in the stack, including the top or bottom position. This flexibility advantageously allows for a more random shuffle and avoids 'dead' areas within the collection stack of cards.

The shuffling device of the present invention advantageously senses the length or width of the cards and adjusts the horizontal distance between the gripping arms so that cards of varying lengths or widths can be suspended. Whether the width or length is sensed depends on the designer's selected location of the grippers within the card collection area.

In one example of the invention, the microprocessor instructs the shuffling device to feed a first card into the card collection area and to grip the card at a width representing the width of a standard group of cards. If the sensors sense that a card is suspended, no adjustments to a horizontal spacing between gripping arms is necessary. If  
5 no suspended cards are sensed, the microprocessor instructs an adjustable gripping support mechanism to move a preselected distance and the gripping and sensing process is repeated. When the final adjustment has been made, cards are suspended and their presence is sensed. The microprocessor then retains this gripping mechanism distance setting. Alternatively, when the processor instructs the grippers to suspend one or more  
10 cards and no suspended cards are sensed, the adjustment sequence is activated. This entire process will be described in further detail, below.

The microprocessor directing the shuffling device is communicatively connected to the device and is most preferably located within the exterior shell of the device. The microprocessor may be programmed to lower the card collection surface within the card  
15 collection area after the at least one card supporting element has contacted and supported cards suspending a group of cards within the card collection area, creating two vertically spaced substacks of cards, one suspended, separated by a gap or opening between the cards. Recognition of the presence of suspended and/or supported card(s) within the card collection area may be provided by sensors that are capable of sensing the presence of  
20 card(s) within the area by physical (e.g., weight), mechanical (e.g., pressure), electrical (e.g., resistance or conductance), optical (e.g., reflective, opacification, reading) or other sensing. The microprocessor may direct movement of one or more individual cards into the gap created between the two segments (upper and lower) of cards. The microprocessor may be programmed to randomly determine a distance that the card  
25 supporting surface must be vertically moved to in order to position at least one specific card. This method, including measurement of card thickness, will be described in more detail below. In the alternative, the microprocessor may be programmed to select a specific card position below or above a certain card, creating the gap. When the card supporting element moves to contact cards within the card collection area, and the

elevator moves the card supporting surface downwardly, a gap is created for receiving the next card. The processor driving the shuffling device may be located in the shuffler, in a distal location such as a central control room), or may be the main game processor in the Automated gaming system.

5           The elevator operates in a unique manner to position cards relative to the pickers or grippers within the shuffling chamber. This unique operation offers significant benefits that remove the need for human intervention in the setup or continuing operation of the shuffling device. Among the alternative and optional unique features of the operation of the shuffling device of the present invention are included the following  
10           sequence of events. These events need not necessary be combined within a single process to represent inventive steps, as individual steps and combinations of two or more steps may be used to define inventive processes.

          To calibrate the shuffling device of the present invention to operate for a particular card size, a calibration set of cards comprising at least one card (usually one,  
15           although two, three, four or more cards could be used) is inserted into the shuffling chamber prior to shuffling. The elevator base plate defining the base of the shuffling chamber moves the calibration set of cards to the position within the chamber approximating a position within the gripper (not necessarily at a level or equal position with the bottom of the grippers), and the grippers move inwardly (towards opposed edges  
20           of the cards) and attempts to grip the card(s). If the gripper grips the card(s), a sensor identifies either that the card(s) have been gripped by the grippers or the card(s) remain on the collection surface of the elevator (depending upon the position of the sensors. If there is no indication that a card(s) has been gripped, then the grippers move inwardly toward each other horizontally a set number of steps (e.g., steps being units of movement  
25           as in movement through a micro stepping motor or unit of movement through any other motivating system), and the process is repeated. This gripping, sensing and moving sequence is repeated until the sensor(s) sense that a card has been lifted off the support plate and/or is supported in the gripper. The microprocessor identifies a fixed progression of steps of predetermined sizes of steps that are used in this gripping

calibration as well as the position that accomplished the gripping. These determinations of card dimensions, gripping positions and elevator position may be done independently and/or in concert.

It is logical to proceed with the gripping identification first. The grippers move inwardly a predetermined distance initially and in the repeat testing. For example, in the first gripping attempt, the grippers may move in 10 or 15 or other number of steps. A larger number than one step or unit is desirable initially to assure that a rapid first grip is attained. After the first grip of a card(s) is sensed, then the microprocessor will widen the grip by fixed numbers of steps (here single steps may be used), with the widening occurring until no card is gripped. Once no card is gripped, a sufficient number of steps are added to the gripper movement to assure gripping and even slight elastic bending of the card by the grippers so that more cards can be supported and so that cards will not slip. This may be 1, 2, 4, 5, 8, 10, 12, 15 or any other number of steps to assure that secure gripping is effected. This procedure defines the "gripping" and "card release" position of the grippers for a particular group of cards. The microprocessor records the stepper motor positions corresponding to the gripper positions and uses this information to position the grippers during shuffling.

Now the platform offset is to be set (as opposed to the gripper offset positioning). The elevator is put in a base or home position, which may be the position of the elevator (the height of the elevator) at the lowest position possible, or at a position below a framing support at the base of the collection chamber or some other predetermined position. The elevator is then raised in a series of a number of steps (again, in the initial gripping attempt, using larger numbers of steps is desirable to speed up the overall process, while during a more refined positioned identification/calibration sequence, smaller numbers of steps, even single steps, would be used) and the grippers are activated after each step, until the card is caught by the gripper for the first time. The number of steps moved each time for the first gripping action is preferably larger than single steps to assure that this card will be gripped at the lowermost edge of the grippers.. Again this may be 1, 2, 3, 4, 5,...8,...10, 15 etc. steps (or any number in between or larger number

of steps). Once the calibration card(s) is gripped, this is an indication that the platform has now raised the cards to at least the bottom of the grippers. Once gripping has occurred, the elevator is then lowered by a smaller number of incremental stop positions (a finer adjustment) and a new position evaluated as to whether the grippers would then grip the calibration card. The process is repeated until the calibration card is just below the lowermost gripping position. This position is then recorded in memory. The repositioning is accomplished by lowering the elevator and support plate to a position well below the grippers and then raising the plate to a position a predetermined number of steps lower than the last position where the card(s) was gripped, and sensing whether the card was gripped at the new position. Depending upon the arrangement of the sensors, plates, and cards, it is possible to merely ungrip the card, then lower the elevator one or more predetermined number of steps, then attempt to regrip the card, and sense whether the card has been gripped.

Once the card has been lowered just below the gripper, a second calibration card is added to the card collection surface. The elevator position is registered/recorded. The precision of the system enables options in the practice of the invention such as the following. After a single card has been gripped, and a position determined where that single card will not be gripped with a slightly lowered elevator position (e.g., movement downward, which may be anywhere from 2 to 20 steps or more), another calibration card or cards may then be added to the shuffling chamber on top of the calibration card(s). The elevator and grippers may then be exercised with the elevator moving single steps, until the sensor(s) determined that one card has been gripped and lifted off the support plate and another card(s) remains on the support plate. To this position is added a number of steps equal to a card thickness, and this final position is defined as the platform offset and identifies the position where the bottom-most card would be lifted off of the support plate.

Prior to inserting the first calibration card, the elevator is raised to a predetermined sensed position in the card collection area, and that position or elevation is recorded in memory. After the first group of cards are inserted and randomized, the

procedure is repeated, this time either measuring the height of the elevator when the top card in the stack was at the original height of the elevator, or measuring a new height of the top of the stack of cards when the elevator returns to that recorded position. The difference in distances represents the thickness of the deck or group of cards. As each  
5 card is fed into the card collection surface, the number of cards is counted and this number is recorded. The processor uses both pieces of information to calculate an average card thickness, and to associate the number of motor steps to one card thickness. This information is then used in positioning the elevator for precise placement in the next shuffle.

10 At this point, all of the remaining cards in the deck(s) may be added to the shuffling chamber (either directly or into the card receiving chamber and then into the card shuffling chamber). The system may then check on the efficiency of the grippers by raising the deck to a level where all cards should be gripped, the grippers grip the entire deck (one, two, three or more times), and the elevator lowered. If no cards are dropped in  
15 the chamber, the system may proceed to normal shuffling procedures. If the grippers leave a card or a card falls back into the shuffling chamber, the gripper action may be automatically or manually (by an operator signal) adjusted to provide greater force on the cards, and the deck lift procedure is then attempted again, until the entire deck is lifted. The entire calibration process may have to be repeated if there is any  
20 uncorrectable failure in a complete deck lift test procedure. The shuffler preferably includes a multiple segment information display as described in Breeding et al., U.S. Patent 6,325,373 entitled "Method and Apparatus for Automatically Cutting and Shuffling Playing Cards", the disclosure of which is herein incorporated by reference. The display may then indicate information relating to the state of the shuffler, such as the  
25 indication "AUTO ADJUST COMPLETE" and the operator may proceed with normal shuffling procedures, with or without further instruction on the display panel.

The calibration process described above is preferably repeated periodically to compensate for swelling and bending of the cards. In a preferred form of the invention, two cards are fed into the device and separated prior to each shuffle to verify that the

device is still calibrated properly. If the cards do not separate, the calibration sequence is repeated. The device of the present invention includes a jam recovery feature similar to that described in Breeding et al., U.S. Patent 6,325,373. However, upon the fourth (or other number of failures) failure to recover from a jam, one or more of the calibration features described above are automatically activated.

This element of the total calibration process will thus calibrate the shuffling device in advance of any shuffling procedure with respect to the position of the bottom card (the card touching the elevator base plate or support plate) by moving the elevator up and down, by gripping and regripping the cards to identify a position where no cards are gripped and then only one card is gripped. The other gripping-regripping procedure within the total calibration process will also identify and calibrate the shuffling apparatus with respect to the unique size of cards placed into the shuffling apparatus. Based on the knowledge of how many cards have been inserted into the shuffling chamber in the set (preferably 1 card and then two cards total), the microprocessor identifies and determines the position of the elevator support plate, and the appropriate position of the elevator support plate with respect to the grippers and also the relative height of the number of cards in the set on the elevator card support plate. This information is stored for use with the particular stack of cards to be used in the shuffling process. When subsequent decks are inserted, the operator may optionally indicate that the decks are 'the same' or sufficiently similar that the entire process need not be performed, or may indicate that the process may be initiated, or the machine may automatically make a check of a single card to determine if it appears to be the same size, and then the shuffling program will be initiated if the card is identified as the same size.

Additionally or alternatively, once the calibration set of cards has been first gripped, the grippers release the cards and regrip the cards, measuring any one or more of the a) position of the grippers relative to each other (with one or more of the two opposed grippers moving, the 'steps' or other measurable indicator of extent of movement or position of the grippers) is determined and registered for use by the microprocessor, b) the force or tension between the grippers (with the calibration set of cards or only one

card) gripped between the grippers, c) the height of a top card (or the single card) in the calibration set when cards are flexed by the force of the grippers (which may be measured by sensors positions in the shuffling chamber), or any other system that identifies and/or measures a property or condition indicative of the gripping of the cards with a force in a range between a force insufficient to support the weight of the calibration set against slippage and bending the cards to a point where a card might lift off other cards in the calibration set. The calibration distance is typically in a range of between 93-99.5% of the length of width of the cards (whichever is being measured by picker movement, usually the length of the cards).

The positioning, repositioning and gripping of the cards are performed automatically and directed by the microprocessor or an additional microprocessor (there may even be a networked central control computer, but a microprocessor in the device is preferred). The elevator and the grippers are moved by steps or micro steps by a microstepping motor or other fine movement control system (e.g., hydraulic system, screw system, geared system, and the like). The use of the automatic process eliminates the need for technicians to set up individual machines, which must be done at regular intervals because of wear on parts or when cards are replaced. As noted, the positioning may be performed with a calibration set as small as a single card. After the automated calibration or position determination has been performed, the microprocessor remembers that position and shuffling can be initiated with the stack of cards from which the calibration cards were taken.

This calibration or preshuffling protocol may be used in conjunction with any system where an elevator is used, whether with grippers, card inserting devices, injectors and the like (as described above) are used, and not only the specific apparatus shown in the figures. A similar calibration system for determining specific positions of carousel chambers in a carousel-type shuffling device may also be used, without grippers. The carousel may be rotated and the position of the shelves in the carousel with respect to other functional elements in the device may be determined. For example, card reading devices, card injection components, card removal elements, and card receiving chambers



may be calibrated with regard to each other. As is understood by those ordinarily skilled in the art, there may be variations chosen among components, sequences of steps, and types of steps performed, with those changes still reflecting the spirit and scope of the invention disclosed herein.

5           In addition, the card collection chamber need not be vertically disposed. The chamber could be angled with respect to the vertical to improve contact between the card edges and the support structure located within the card collection area.

10           As noted, this description reflects a detailed description of the preferred practice of the invention with grippers. Alternative systems, such as those with injectors or stack wedges may also be used with the calibration system of the invention with modifications reflecting the different systems. For example, where the calibration in the preferred embodiment addresses the level of the grippers with respect to cards and the elevator support plate, the system may be translated to calibration of air injectors, wedge lifters, and blade or plate injectors. This is done with an equivalent procedure for identifying the position of a card(s) placed on the support plate. For example, rather than repeated tests with a gripper, repeated tests with an air injector (to see when a card is ejected or injected by its operation), repeated tests with a blade or plate injector (to see when a card is ejected or injected by its operation), or a wedge separator with associated card(s) insertion (to see when the stack [e.g., a single card or a number of cards] are raised or  
15           when a card may be ejected or injected by its operation with minimum force).  
20

          The device of the present invention is also capable of monitoring card thickness and uses this information to determine the location or position in the stack where separation is to occur with great accuracy. When combined with the ability to read card rank and suit, the device is capable of verifying that all cards are present and the find  
25           order of the cards.

          In another embodiment, a first sensor located in the shuffling chamber senses the height of the platform within the shuffling chamber in its lowermost position prior to the beginning of the randomization process, when no cards are in the shuffling chamber. The

sensor could also sense the platform position in any other predetermined or “home” position or assign such nomenclature to a position.

5 After randomization, when all cards have been transferred into the shuffling chamber, the platform is returned to this same position, and the same or another sensor located in the shuffling chamber (also referred to herein as the collection chamber) may sense the height of the top card in the stack. The difference between the two measurements represents the thickness of the stack of cards. This is an alternate method of measuring stack thickness.

10 Sensors (such as optical sensors, sonic sensors, physical sensors, electrical sensors, and the like, as previously described) sense cards as they are individually fed from the in-feed tray into the shuffling chamber. This information is used by the microprocessor to verify that the expected number of cards is present. In one example of the invention, if cards are missing or extra cards are present, the display will indicate a misdeal and will automatically unload.

15 The microprocessor uses the two height measurements and the card count to calculate an average card thickness. This thickness measurement is used to determine what height the elevator must be in order to separate the stack between any two “target” cards.

20 The average card thickness can be recalculated each time the shuffler is activated upon power up, or according to a schedule such as every 10 to 30 minutes, with 20 minute intervals as one preferred example.

25 The inventors have recognized that deck thickness increases the more the cards are used, and as the humidity in the air increases, and when cards become worn. Under humid conditions, it might be desirable to check the card thickness more often than every 20 minutes. Under extreme conditions of continuous use and high humidity, it might be desirable to recalculate an average card thickness after the completion of every shuffle.

A novel method of determining an average card thickness measurement during shuffling is disclosed herein as an invention. The method includes providing a stack of cards, providing a card feeder capable of relative motion between the card feeder and the

stack, and measuring a home position of the stack platform. The home position indicating a height of the elevator platform when no cards are present in the stacking area, feeding cards into the stacking area, counting a number of cards placed into the stacking area as they are fed, sensing a height of a topmost card in the stack when the  
5 elevator is returned to the same home position, and computing an average card thickness from the collected information (e.g.,  $\text{stack height/number of cards} = \text{height/card}$ ).

The average card thickness is advantageously used to determine the position of card grippers used to grasp cards. Upon lowering the platform beneath the grippers, an opening is formed at a precise predetermined location, allowing precise placement of the  
10 next card between two "target" cards.

According to the present invention, a sensor is positioned at a point of insertion into the group of cards in the card collection area. Each time a gap is formed, the sensor verifies that the gap is open, e.g.—that no cards are suspended or are hanging due to static forces. The card feeder activates when the sensor indicates the opening is clear.  
15 This method avoids jams and provides faster shuffling as compared to programming a time delay between the gripping of cards and subsequent lowering of the elevator and the insertion of the next card.

Another general description of a preferred shuffling/randomization device according to the invention is a device for forming a random set of playing cards  
20 comprising: a top surface and a bottom surface of said device; a receiving area for supporting an initial set of playing cards to be randomized; a randomizing system for randomizing the initial set of playing cards; a collection surface in a card collection area for receiving randomized playing cards, the collection surface being moveable in a vertical direction. In one example of the invention, cards are received onto the collection  
25 surface, either positioned directly on the surface or positioned indirectly on a card supported by the surface. All cards being randomized in this example are inserted into the card collection area at a location below the top surface of the device. Cards are fed individually off of the bottom of the stack located in the card receiving area and into the card collection area in one example of the invention.

An elevator is provided for raising the collection surface so that at the conclusion of shuffling, at least some randomized cards are elevated to a position at or above the top surface of the device. The elevator may be capable of raising all or part of the randomized cards at or above the top surface of the device. A cover may be provided to protect or mask the cards until they are elevated into a delivery position from which a dealer may remove the cards manually. The device may have a stack stabilizing area defined by a confining set of walls defining a shuffled card delivery area that confine all randomized cards along at least two, and preferably three edges after the randomized cards are elevated.

Alternatively, the card collection surface itself, elements positioned on the top surface of the shuffler or elements moved above the top surface of the shuffler may act to stabilize the cards so that they are more easily removed by the dealers hand(s). The present invention also contemplates raising the shuffled group of cards to the top surface of the shuffler, where there are no confining structures around the cards. In one example of the invention, the top surface of the shuffler is flush mounted into the gaming table surface, and the cards are delivered directly to the gaming table surfaces after shuffling.

The delivery area may be positioned such that its lower interior surface is at the same elevation as the top surface of the shuffler. The lower interior surface may be elevated above the top surface, or positioned beneath the top surface of the shuffler. In one example of the invention, the lower interior surface is at the same elevation as the top of the exterior of the shuffler. If the shuffler is mounted into and completely surrounded by a gaming table surface, it would be desirable to deliver cards so that the bottom card in the stack is at the same elevation as the gaming table surface.

The card receiving area may be sloped downwardly towards the randomizing system to assist movement of playing cards. The device may have at least one pick-off roller to remove cards one at a time from the card receiving area and to move cards, one at a time towards the randomizing components of the system. Although in one example of the invention the randomizing system suspends cards and inserts cards in a gap created below the suspended cards, other randomization systems can be employed, such as the

random ejection shuffling technique disclosed in Sines U.S. Patent 5,584,483, the disclosure which hereby is incorporated by reference. The at least one pair of speed up rollers desirably receive cards from the at least one pick-off roller. A microprocessor preferably controls movement of the pick-off roller and the at least one pair of speed up rollers. The first card is preferably moved by the pick-off roller so that, as later described in greater detail, movement of the pick-off roller is altered (stopped or tension contact with the card is reduced or ended) so that no card other than the first (lowermost) card is moved by either the pick-off roller or the at least one pair of speed up rollers. This can be done by sensing of the movement or tension on the first card effected by the at least one pair of rollers, causing the pick-off roller to disengage from the drive mechanism and freely rotate and to not propel the card.

The microprocessor, for example, may be programmed to direct the pick-off roller to disengage from the drive mechanism and to cease propelling a first card being moved by the pick-off roller when it is sensed that the first card is being moved by the at least one pair of rollers. A preferred randomization system moves one card at a time into an area overlying the collection surface. It is desirable to have one card at a time positioned into a randomized set of playing cards over the playing card collection surface. Again, as with the first general structure, the card collection area may be bordered on two opposed sides by two vertically disposed horizontally opposed movable card supporting elements. There is preferably an insertion point, such as an opening or slot to the card collection area that is located below a bottom edge of the two movable card supporting elements. The card supporting surface is vertically positionable within the card collection area, usually under the control and direction of a microprocessor. For example, the card supporting surface is moved by a motivator or elevator that is able to move incremental vertical distances that are no greater than the thickness of a playing card, such as incremental vertical distances that are no greater than one-half the thickness of a playing card. The motor may be, for example, a micro-stepper motor or an analog motor.

A sensor may be present within the collection area, below the top surface of the device, the sensor detecting a position of a top card of a group of cards in the card

collection area below the group of suspended cards. In the alternative or in concert, the sensor detects the level of the card collection surface. In addition, a preferred device monitors the elevation of the top card when the two groups of cards are combined into one group, and adjusts for changes in the thickness of the deck, due to swelling,  
5 humidity, card wear, bowing of cards, etc. A microprocessor is preferably present in the device to control vertical movement of the card collection surface. The sensor may identify the position of the collection surface to place the top card at a position level with the bottom of at least one card supporting element that is movable substantially horizontally from at least one side of the collection area towards playing cards within the  
10 card collection area.

In one example of the invention, an opening such as a slot is provided in a side wall of the card collection area to permit transfer of cards from the card receiving area into the card collection area. The side wall may comprise a substantially solid support structure; adjoining edges of a plurality of vertical "L" shaped corner support structures,  
15 or other equivalent structure capable of retaining a stack of cards in a substantially upright position. The microprocessor may be programmed to determine a distance that the card supporting surface must be vertically moved to position at least one specific card, including or other than the top card at a bottom edge of the at least one card supporting element when the card supporting element moves to contact cards within the card collection area. As previously described, the at least one card supporting element  
20 may comprise at least two elements such as gripping pads that move from horizontally opposed sides of the collection area towards playing cards within the card collection area.

The microprocessor may be programmed to lower the card collection surface within the card collection area after the at least one card supporting element has contacted and supported cards within the card collection area, creating two vertically spaced apart  
25 segments or substacks of cards. The microprocessor directs movement of an individual card into the card supporting area between the two separated segments of cards. The microprocessor may direct movement of playing card moving elements within the device. The microprocessor randomly assigns final positions for each card within the initial set of

playing cards, and then directs the device to arrange the initial set of playing cards into those randomly assigned final positions to form a randomized final set of playing cards. Each card is inserted into the building stack of collected (randomized or shuffled) cards by positioning them in respect to the other cards already in the stack. Thus, even if a first  
5 card is not intended to be adjacent to a particular card, but is intended to be above that particular card, the first card is positioned above (and possibly adjacent to) the particular card, and intervening cards in the intended sequence added between the first card and the particular card.

In one embodiment of the invention, the card receiving area is located such that  
10 individual cards are fed off of the bottom of the stack, through the slot formed in the card collection area, directly beneath the gripping elements. In another example of the invention, a card loading elevator is provided so that the cards can be loaded into the card receiving area at an elevation above that of the first embodiment. The elevator then lowers the cards to a vertical position aligned with the feed mechanism. The use of an  
15 elevator on the card loading area is also an ergonomic benefit as the dealer can keep hand and arm movements at a consistent level and does not have to reach into the device or have to drop cards into the device. The cards to be randomized can be inserted at a level approximately equal to the top of the shuffler, which can also be the height at which a randomized set of cards can be removed from the device.

When the shuffling device is used to process large batches of cards, such as  
20 groups of eight decks, it is desirable to provide a feed elevator to lower the entire batch of cards beneath the top surface of the shuffler, prior to shuffling. The card feeding mechanism from the card receiving area to the card collection or shuffling area is necessarily positioned lower in a shuffler that processes more cards than in a shuffler that  
25 processes fewer cards.

When a large number of cards are to be inserted into the machine for shuffling, a retaining structure may be provided, consisting of a card stop or frame to limit card movement on up to three sides of the elevator. The open side or sides permit the dealer

to load the stack from the side of the elevator, rather than trying to load the elevator from above, and allowing cards to fall freely and turn over.

A randomizing elevator is provided for moving the cards being randomized and operates to raise and lower the bottom card support surface of the card collection area.

5 This elevator moves during randomization, and also aids in the delivery of the shuffled group of cards by raising the shuffled cards to a delivery area. Reference to the figures will assist in appreciation and enablement of the practice of the present invention.

Upwardly extending side walls on the card collection surface, an elevator arm or extension of an elevator arm, or another element attached to the arm may move with the  
10 elevator and be used to move other portions of the shuffling apparatus. For example, the arm extension may be used to lift hinged or sliding covers over the cards as the cards are raised above a certain level that exceeds the normal shuffling elevation of the elevator.

Figure 9 shows a partial perspective view of the top surface **4h** of a first shuffling apparatus **2h** according to a practice of the invention. In this example of the invention,  
15 the device randomizes one or two decks of cards. The shuffling apparatus has a card accepting/receiving area **6h** that is preferably provided with a stationary lower support surface that slopes downwardly from the nearest outer side **9h** of the shuffling apparatus **2h**. A depression **10h** is provided in that nearest outer side **9h** to facilitate an operator's ability to place or remove cards into the card accepting/receiving area **6h**. The top  
20 surface **4h** of the shuffling apparatus **2h** is provided with a visual display **12h** (e.g., LED, liquid crystal, micro monitor, semiconductor display, etc.), and a series of buttons, touch pads, lights and/or displays **24h** and **26h**. These elements on the top surface **4h** of the shuffling device **2h** may act to indicate power availability (on/off), shuffler state (jam, active shuffling, completed shuffling cycle, insufficient numbers of cards, missing cards,  
25 sufficient numbers of cards, complete deck(s), damaged or marked cards, entry functions for the dealer to identify the number of players, the number of cards per hand, access to fixed programming for various games, the number of decks being shuffled, card calibration information and the like), or other information useful to the operator or casino.



Also shown in Figure 9 is a separation plate **20h** with a beveled edge **21h** and two manual access facilitating recesses **22h** that assists an operator in accessing and removing jammed cards between the card accepting area **6h** and the shuffled card return area **32h**. The shuffled card return area **32h** is shown to be provided with an elevator surface **14h** and two separated card-supporting sides **34h**. In a preferred embodiment, sides **34h** are removable. When the shuffler is flush-mounted into and surrounded by the top of a gaming table surface, removal of sides **34h** enables the device to lift shuffled groups of cards onto the gaming table surface for immediate use. The card supporting sides **34h** surround a portion of the elevator surface **14h** with interior faces **16h** and blocking extensions **18h**. It is desirable to provide rounded or beveled edges **11h** on edges that may come into contact with cards to prevent scratching, catching or snagging of cards, or scratching of operators' fingers or hands.

Figure 10 shows a cutaway side view of a first embodiment of a shuffling apparatus **112** according to the present invention. The top surface **114** is shown with a separation plate **120** and the side panels **134** (card supporting sides) of the shuffled card return area **132**. The card accepting/receiving area **116** is recessed with respect to the top surface **104** and is shown with a declining sloping support surface **118**. At the front **135** of the sloping surface **118** is an opening **136** (not able to be seen in the direct side view) or slot through which a bottom pick-off wheel **138** may contact a bottom card in an unshuffled set of cards (not shown) within the card accepting/receiving area **116**. The bottom pick-off roller **138** drives a card in direction **140** by frictional contact towards a first pair of nip rollers or off-set rollers **142**. In one example of the invention, the upper roller of off-set rollers **142** is a break roller. This break roller retains the second top card for separation in the event that two cards are fed at the same time. In a preferred form of the invention, the upper roller does not rotate. In another form of the invention, the upper roller rotates, but is rotationally constrained.

There are two additional pairs **144**, **146** of nip rollers or off-set rollers acting in concert (or only one of each pair is being driven) to move cards first moved by the first set of nip rollers **142**. In a preferred practice of the present invention, the operation of the

apparatus 112 may perform in the following manner. When a card (not shown) is moved from the unshuffled card accepting/receiving area 116, eventually another card in a stack of cards within the card accepting/receiving area 116 is exposed. The apparatus is designed, programmed and controlled to operate so that individual cards are moved into  
5 the first set of nip rollers or off-set rollers 142. If more than one card from the card accepting/receiving area advances at any given time (even if in partial sequence, with a portion of one card overlapping another card), it will be more difficult or even impossible for the apparatus to direct individual cards into predetermined positions and shuffle the cards randomly.

10 If two cards are moved at the same time and positioned adjacent to each other, this uncontrollably decreases the randomness of the shuffling apparatus. It is therefore desirable to provide a capability whereby when a card is moved into the control area of the first set of nip rollers or off-set rollers 142, the drive function of the bottom pick-off roller 138 ceases on that card and/or before the bottom pick-off roller 138 drives the next  
15 card. This can be effected by a wide variety of techniques controlled or directed by a microprocessor, circuit board, programmable intelligence or fixed intelligence within the apparatus.

Among the non-limiting examples of these techniques are 1) a sensor so that when a pre-selected portion of the card (e.g., leading edge, trailing edge, and mark or  
20 feature on the card) passes a reading device, such as an optical reader, the bottom pick-off roller 136 is directed to disengage, revolve freely, or withdraw from the bottom of the set of cards; 2) the first set of nip rollers or off-set rollers 144 may have a surface speed that is greater than the surface speed of the bottom pick-off roller 138, so that engagement of a card applies tension against the bottom pick-off roller 138 and the roller  
25 disengages with free rolling gearing, so that no forward moving (in direction 140) forces are applied to the first card or any other card exposed upon movement of the first card; 3) a timing sequence so that, upon movement of the bottom pick-off roller for a defined period of time or for a defined amount of rotation (which correlates into a defined distance of movement of the first card), the bottom pick-off roller 138 disengages,

withdraws, or otherwise stops applying forces against the first card and thereby avoids applying forces against any other cards exposed by movement of the first card from the card accepting/receiving area 116 and 4) providing a stepped surface (not shown) between pick-off roller 138 and off-set rollers 146 that contacts a leading edge of each  
5 card and will cause a card to be held up or retained in the event that more than one card feeds at a time.

The cards are eventually intended to be fed, one-at-a-time from final nip rollers or off-set rollers 146 into the card mixing area 150. The cards in the mixing area 150 are supported on elevator platform 156. The platform 156 moves the stack of cards present  
10 in the mixing area up and down as a group in proximity with a pair of separation elements 154. The pair of separation elements 154 grip an upper portion of cards, and supports those cards while the elevator drops sufficiently to provide an opening for insertion of a card into the stack. This movement within the apparatus 112 in the performance of the shuffling sequence offers a significant speed advantage in the  
15 shuffling operation as compared to U.S. Patent No. 5,683,085, especially as the number of cards in the card mixing area 150 increases. Rather than having to lower the entire stack of cards to the bottom of the card receiving area and reposition the pickers (as required by U.S. Patent No. 5,683,085), the cards in the present apparatus may be dropped by the pickers or the elevator needs to move only a slight distance to recombine  
20 the cards supported by the separation element 154 (a gripper, and insertion support, fingers, friction engaging support, rubber fingers, etc.) with the cards supported on the elevator platform 156.

The stationary pair of gripping pads also maintains the alignment of the pads with respect to each other and grips the cards more securely than the device described in U.S.  
25 Patent 5,683,085, reducing or eliminating the unintentional dropping of a card or cards that were intended to be gripped, rather than lowered. Whenever cards are dropped, the randomness of the final shuffle may be adversely affected. Although the first example of the invention shows a pair of oppositely positioned gripping members, it is possible to utilize just one gripper. For example, the opposite vertical support surface could be

equipped with a rubber or neoprene strip, increasing frictional contact, allowing only one gripper to suspend groups of cards.

The elevator of a device with stationary grippers may then be moved to the next directed separation position, which would require, on average, less movement than having to reset the entire deck to the bottom of the card supporting area and then moving the picker, and then raising the picker to the card insertion point, as required in U.S. Patent No. 5,683,085.

The microprocessor (not shown) controls and directs the operation of the shuffling apparatus 112. The microprocessor also receives and responds to information provided to it. For example, a set of sensing devices 152 are used to determine the movement point of the elevator that positions the top card in a set of cards (not shown) within the card mixing area 150 at a specific elevation. The sensing devices 152 identify when an uppermost card on the platform 156 or the top of the platform itself is level with the sensors 152. This information is provided to the microprocessor. A reading system 170 may also be used to provide information, such as the number of cards that have been fed from the card accepting/receiving area 116 into the card mixing area 150 so that the number of cards shuffled and the number of cards present on the platform 150 at any given time is known. This information, such as the number of cards present within the card mixing area 150, is used by the microprocessor, as later explained to randomly arrange and thus shuffle cards according to the programming of the system.

For example, the programming may be performed as follows. The number of cards in a set of cards intended to be used in the system is entered into the memory of the microprocessor. Each card in the set of cards is provided with a specific number that is associated with that particular card, herein referred to as the original position number. This is most conveniently done by assigning numbers according to positions within the original (unshuffled) set of cards. If cards are fed from the bottom of the stack into the randomizing apparatus, cards are assigned numbers from the bottom to the top. If cards are fed from the top of the stack or the front of a stack supported along its bottom edges, then the cards are numbered from top to bottom, or front to rear.

A random number generator (which may be part of the microprocessor, may be a separate component or may be external to the device) then assigns a random position number to each card within the original set of cards, the random position number being the randomly determined final position that each card will occupy in the randomly associated set of cards ultimately resulting in a shuffled set of cards. The microprocessor identifies each card by its original position number. This is most easily done when the original position number directly corresponds to its actual position in the set, such as the bottom-most card being CARD 1, the next card being CARD 2, the next card being CARD 3, etc. The microprocessor, taking the random position number, then directs the elevator to move into position where the card can be properly inserted into the randomized or shuffled set of cards. For example, a set of randomized positions selected by a random number generator for a single deck is provided below. OPN is the Original Position Number and RPN is the Random Position Number.

OPN	RPN		OPN	RPN		OPN	RPN		OPN	RPN
1	13		14	10		27	14		40	4
2	6		15	21		28	31		41	20
3	39		16	29		29	50		42	47
4	51		17	33		30	7		43	37
5	2		18	11		31	46		44	30
6	12		19	52		32	23		45	24
7	44		20	5		33	41		46	38
8	40		21	18		34	19		47	15
9	3		22	28		35	35		48	36
10	17		23	34		36	26		49	45
11	25		24	9		37	42		50	32
12	1		25	48		38	8		51	27
13	49		26	16		39	43		52	22

The sequence of steps in the shuffling or randomizing procedure may be described as follows for the above table of card OPN's and RPN's. OPN CARD 1 is carried from the card receiving area 116 to the final nip rollers or off-set rollers 146. The final nip rollers or off-set rollers 146 place CARD 1 onto the top of the platform. The

platform has been appropriately positioned by sensing by sensors 152. OPN CARD 2 is placed on top of CARD 1, without the need for any gripping or lifting of cards. The microprocessor identifies the RPN position of CARD 3 as beneath both CARD 1 and CARD 2, so the elevator 156 lifts the cards to the gripping element 154 which grips both CARD 1 and CARD 2, then supports those two cards while the elevator retracts, allowing CARD 3 to be placed between the elevator platform 156 and the two supported cards. The two cards (CARD 1 and CARD 2) are then placed on top of CARD 3 supported by the platform 156. The fourth card (CARD 4) is assigned position RPN 51. The elevator would position the three cards in the pile so that all three cards would be lifted by the card separation element, and the fourth card inserted between the three cards (CARD 1, CARD 2 and CARD 3) and the platform 156. The fifth card (CARD 5) has an RPN of 2, so that the apparatus merely requires that the four cards be positioned below the insertion point from the last two nip rollers 146 by lowering the platform 150. Positioning of the sixth card (CARD 6) with an RPN of 12 requires that the elevator raise the complete stack of cards, the sensors 152 sense the top of the stack of cards, elevate the stack of cards so that the separators 154 grip only the top two cards (RPN positions 2 and 6), lower the platform 156 slightly, and then CARD 6 with an RPN of 12 can be properly inserted into an opening in the developing randomized set of cards. This type of process is performed until all 52 cards (for a single deck game) or all 104 cards (for a double deck game) are randomly distributed into the final randomized set or shuffled set of cards. The apparatus may be designed for larger groups of cards than single fifty-two card decks, including 52 card decks with or without special (wild cards or jokers) cards, special decks, two fifty-two card decks, and two fifty-two card decks plus special cards. Larger groupings of cards (e.g., more than 108 cards) may also be used, but the apparatus of the first example of the invention has been shown as optimized for one or two deck shuffling.

Elevation of the elevator or platform 156 may be effected by any number of commercially available type systems. Motivation is preferably provided by a system with a high degree of consistency and control over the movement of the elevator, both in individual move (e.g., individual steps or pulses) and in collective movement of the

elevator (the steps or revolutions made by the moving system). It is important that the elevator is capable of providing precise and refined movement and repeated movements that do not exceed one card thickness. If the minimum degree of movement of the elevator exceeds one card thickness, then precise positioning could not be effected. It is preferred that the degree of control of movement of the elevator does not exceed at least one-half the card thickness. In this manner, precise positioning of the cards with respect to the separating elements 154 can be effected. Additionally, it is often desirable to standardize, adjust, or calibrate the position of the elevator (and/or cards on the elevator) at least once and often at intervals to assure proper operation of the apparatus 102. In one example of the invention, the microprocessor calls for recalibration periodically, and provides the dealer with a warning or calibration instructions on the display 12.

As later described, a micro stepping motor or other motor capable of precise and small controlled movements is preferred. The steps for example may be of such magnitudes that are smaller than the card thickness, such as for example, individual steps of 0.0082 inches (approximately less than 1 card thickness), 0.0041 inches (less than  $\frac{1}{2}$  card thickness), 0.00206 inches (less than about  $\frac{1}{4}$  card thickness), 0.0010 inches (less than about  $\frac{1}{8}$ <sup>th</sup> card thickness), 0.00050 inches (less than about  $\frac{1}{16}$ <sup>th</sup> card thickness), 0.00025 inches (less than about  $\frac{1}{32}$ <sup>nd</sup> card thickness) 0.000125 inches (less than about  $\frac{1}{64}$ <sup>th</sup> card thickness), etc.

Particularly desirable elevator control mechanisms would be servo systems or stepper motors and geared or treaded drive belts (essentially more like digital systems). Stepper motors, such as micro-stepper motors, are commercially available that can provide or can be readily adjusted to provide incremental movements that are equal to or less than one card thickness, with whole fractions of card thicknesses, or with indefinite percentages of card thicknesses. Exact correspondence between steps and card thickness is not essential, especially where the steps are quite small compared to the card thickness. For example, with a card thickness of about 0.279 mm, the steps may be 0.2mm, 0.15mm, 0.1mm, 0.08mm, 0.075mm, 0.05mm, 0.04mm, 0.01mm, 0.001mm or smaller, and most values there between. It is most desirable to have smaller values, as some

values, such as the 0.17mm value of a step, can cause the gripper in the separation element to extend over both a target position to be separated and the next lower card in the stack to be gripped, with no intermediate stepping position being available. This is within the control of the designer once the fundamentals of the process have been understood according to the present description of the practice of the invention. As shown in Figure 2, a drive belt **164** is attached to two drive rollers **166** which move the elevator platform **156**. The belt **164** is driven by a stepper motor system **171** that is capable of 0.00129 inch (0.003 mm) steps.

Figure 11 shows a perspective cutaway of the drive rollers or nip rollers **142**, **144** and **146** of a first example of the invention. These are not truly sets of nip rollers, but are off-set rollers, so that rollers **142a** and (not shown), **144a** and **144b**, **146a** and **146b** are not precisely linearly oriented. By selecting a nip width that is not so tight as to press a card from both sides of the card at a single position, and by selecting offset rollers rather than aligned nip rollers, fluid movement of the card, reduced damage of the card, and reduced jamming may be provided. This is a particularly desirable aspect of a preferred practice of the present invention, which is shown also in Figure 4.

Figure 12 shows a set of off-set rollers **144a**, **144b**, **144c**, **144d** and **144e** transporting a card **200**. The card **200** is shown passing over rollers **144a** and **144d** and under rollers **144b**, **144c** and **144e**. As can be seen, the rollers are not capable of contacting a card to precisely overlap at a specific point on opposite sides of a card.

Figure 13 shows a cross-sectional view of one embodiment of a gripping system **404** that may be used in the practice of the invention. The Figure shows two oppositely spaced support arms **406** and **408** that support gripping elements **410** and **412**, which comprise semi-rigid gripping pads **414** and **416**. These gripping pads **414** and **416** may be smooth, grooved, covered with high friction material such as rubber or neoprene, ribbed, straight, sloped or the like to take advantage of various physical properties and actions. The support arms **406** and **408** are attached to separately moveable positioning arms **418** and **420**. These positioning arms are referred to as separately moveable, in that they are not physically connected, but one tends to move from left to right while the other



moves right to left (with respect to the view shown in Figure 13) as the two positioning arms move in and out (substantially horizontally) to grip or release the cards. However, preferably they do not move independently, but should move in concert. It is also desirable that they are fixed with respect to the vertical. If the positioning arms moved completely independently (horizontally, during gripping), with only one moving to attempt to contact the cards at a time, the first contacting arm could move cards out of vertical alignment. For this reason, it is preferred that two opposed gripping arms be used.

Although the arms may not move the contact pads **414** and **416** into contact with absolute precision, they should contact opposite edges of the cards at approximately the same time, without moving any cards more than 5% of the length of a card (if contacted lengthwise) or 7% of the width (if contacting the cards widthwise). An example of one mechanism for moving the positioning arms in concert is by having a drive belt **426** that engages opposite sides of two connectors **422** and **424** that are attached to positioning arms **420** and **418**, respectively. The belt **426** contacts these connectors **422** and **424** on opposite sides, such as contact connector **424** on the rear side, and contact connector **422** on the front side. As the belt **426** is driven by rotors **428** and **430**, with both rotors **428** and **430** turning in direction **432**, connector **422** will be moved from left-to-right, and connector **424** will be moved from right to left. This will likewise move contact pads **414** and **416** inwardly to grip cards. The use of such pads is much preferred over the use of rigid, pointed, spatula elements to separate cards, as these can damage cards, not only increasing the need for replacement, but also by marking cards which could reduce security.

Alternative constructions comprise a flat elastic or a rubbery surface with knobs or nubs that extend upwardly from the surface to grab cards when pressed into contact with the sides of the cards. These elements may be permanently affixed to the surfaces of the pickers or may be individually removable and replaceable. The knobs and the flat surface may be made of the same or different materials, and may be made of relatively

harder or softer, relatively rigid or relatively flexible materials according to design parameters.

5 The apparatus may also contain additional features such as card reading sensor(s) such as an optical sensor, neural sensing network, a video imaging apparatus, bar code reading, etc. to identify suits and ranks of cards; feed means for feeding cards sequentially past the sensor; at various points within the apparatus; storing areas in which the cards are stored in a desired order or random order; selectively programmable artificial intelligence coupled to the sensor(s) and to said storing areas to assemble in said storing areas groups of articles in a desired order; delivery systems for selectively  
10 delivering the individual articles into the storing areas, and collector areas for collecting collated or randomized sub-groups of cards.

The sensor(s) may include the ability to identify the presence of an article in particular areas, the movement or lack of movement in particular areas, the rank and/or value of a card, reading of cards to identify spurious or counterfeit cards and detection of  
15 marked cards. This can be suitably effected by providing the sensor with the capability of identifying one or more physical attributes of an article. This includes the sensor having the means to identify indicia on a surface of an article. The desired order may be a specific order of one or more decks of cards to be sorted into its original pack order or specific order, or it may be a random order into which a complete set of articles is  
20 delivered from a plurality of sets of randomly arranged articles. For example, the specific order may be effected by feeding cards into the card accepting area with a sensor identifying the suit and rank, and having a pre-established program to assign cards, based upon their rank and suit, into particular distributions onto the elevator platform. For example, a casino may wish to arrange the cards into pack order at the end of a shift to  
25 verify all cards are present, or may want to deal cards out in a tournament in a specified random order. The sensing can take place in the card receiving area when the cards are stationary, or while the cards are in motion.

The suit, rank and position of all cards in the card accepting/receiving area will then be known, and the program can be applied to the cards without the use of a random

number generator, but with the microprocessor identifying the required position for that card of particular suit and rank. The card may also be read between the off-set rollers or between the last off-set roller and the platform, although this last system will be relatively slow, as the information as to the card content will be known at such a late time that the platform cannot be appropriately moved until the information is obtained.

For example, the desired order may be a complete pack of randomly arranged playing cards sorted from holding means which holds multiple decks, or a plurality of randomly oriented cards forming a plurality of packs of cards. This may be achieved by identifying the individual cards by optical readers, scanners or any other means and then under control of a computer means such as a micro-processor, placing an identified card into a specific collector means to ensure delivery of complete decks of cards in the desired compartment. The random number generator is used to place individual cards into random positions to ensure random delivery of one to eight or more decks of cards, depending on the size of the device.

In one aspect the invention, the apparatus is adapted to provide one or more shuffled packs of cards, such as one or two decks for poker games or blackjack. According to another aspect of the invention, a method of randomizing a smaller or larger group of cards is accomplished using the device of the present invention. According to the invention, the method includes the steps of 1) placing a group of cards to be randomized into a card in-feed tray; 2) removing cards individually from the card in-feed tray and delivering the cards into a card collection area, the card collection area having a moveable lower surface, and a stationary opening for receiving cards from the in-feed tray; 3) elevating the moveable lower surface to a randomly determined height; 4) grasping at least one edge of a group of cards in the card collection area at a point just above the stationary opening; 5) lowering the moveable lower surface to create an opening in a stack of cards formed on the lower surface, the opening located just beneath a lowermost point where the cards are grasped; and 6) inserting a card removed from the in-feed tray into the opening. According to the method of the present invention, steps 2

through 6 are repeated until all of the cards originally present in the in-feed tray are processed, forming a randomized group of cards.

As described above, the method and apparatus of the present invention can be used to randomize groups of cards, as well as sort cards into a particular desired order.

5 When sensing equipment is used to detect rank and suit of the cards, the cards can be arranged in any predetermined order according to the invention. It is to be understood that numerous variations of the present invention are contemplated, and the disclosure is not intended to limit the scope of the invention to the examples described above. For example, it might be advantageous to tip the card mixing area 150 slightly such that a top  
10 portion is further away from the card receiving area 116 than a bottom portion. This would assist in aligning the stack vertically in area 150 and would increase the efficiency and accuracy of the randomization or ordering process. In one preferred embodiment, the card receiving area 150 is tipped between 3 and 8 degrees from the vertical.

In another embodiment of the invention, the shuffler is mounted into the table  
15 such that in-feed tray or card receiving area 116 is recessed beneath the top surface of a gaming table, and a lower horizontal surface 156 of the delivery area or card return area 132 in its upright position is flush with the elevation of the gaming table surface.

Although the machine can sit on the table top, it is preferably mounted on a bracket having a support surface located beneath the gaming table surface, and is  
20 completely surrounded by the table top, enabling a dealer to obtain and return cards without undue lifting above the surface of the gaming table. In one embodiment, the entire shuffler is mounted into the gaming table such that the in-feed tray and card return areas are either flush or approximately flush with the gaming table surface. Such an arrangement would be particularly suited for use in conventional poker rooms.

25 In a second example of the invention, the device is configured to process larger groups of cards, such as a stack of eight complete decks. The individual components operate in much the same manner, but the specific configuration is designed to accommodate the greater height of the stack.

Figure 14 shows a vertical perspective view of another apparatus **500** according to the invention. That apparatus **500** is shown with a flip-up cover **502** with sections **504** and **506** that overlay the elevator platform **512** and the card insertion area **510**. An extension or tab **507** is provided to nest into open area **508** to assist lifting of the flip-up cover **502** when needed. The open area **508** leaves some additional space for a finger or tool to be inserted against the extension **507** to assist in its lifting. That additional space may be designed to accommodate only a tool so as to reduce any possibility of ready player opening of the shuffling apparatus **500**. In a preferred embodiment of the invention, there is provided an arm extension **514** of the elevator that contacts an internal edge **513** of the flip-up cover **502**, here with a roller **515** shown as the contact element, to lift the cover **502** when the elevator platform **512** rises to a level where cards are to be removed, the extension **514** forces the cover **502** to lift from the top **517** of the apparatus **500**. The extension **514** also will buffer playing cards from moving as they are lifted from the elevator platform **512**, although additional elements (not shown) may be used to restrain movement of the cards when elevated to a removal level. In this example of the invention, side panels are not used to stabilize the stack of delivered cards.

Figure 14 also shows a display panel **516**, which may be any format of visual display, particularly those such as LED panels, liquid crystal panels, CRT displays, plasma displays, digital or analog displays, dot-matrix displays, multi-segment displays, fixed panel multiple-light displays, or the like, to provide information to a viewer (e.g., dealer, casino personnel, etc.). The display panel **516** may show any information useful to users of the apparatus, and show such information in sufficient detail as to enable transfer of significant amounts of information. Such information might include, by way of non-limiting examples, the number of cards present in the apparatus, the status of any shuffling or dealing operations (e.g., the number of complete shuffling cycles, hand information (such as the number of hands to be dealt, the number of hands that have been dealt, the number of cards in each hand, the position to which a hand has been dealt, etc.), security information (e.g., card jam identification, location of card jams, location of stuck cards, excess cards in the container, insufficient cards in the container, unauthorized entry

into the apparatus, etc.), confirmation information (e.g., indicating that the apparatus is properly corresponding to an information receiving facility such as a network or microprocessor at a distal or proximal location), on-off status, self-check status, and any other information about play or the operation of the apparatus that would be useful. It is preferred that the display and the software driving the display be capable of graphics display, not merely alphanumeric.

Buttons 518 and 520 can be on-off buttons, or special function buttons (e.g., raise elevator to the card delivery position, operate jam sequence, reshuffle demand, security check, card count demand, etc.) and the like. A sensor 524 (e.g., optical sensor, pressure sensor, magnetic detector, sonar detector, etc.) is shown on the elevator platform 512 to detect the presence of cards or other objects on the elevator platform 512.

Figure 15 is a side cutaway view of an apparatus 600 according to an aspect of the invention, which may be compared with Figure 10 to provide an explanation of components and some of the variations possible within the practice of the invention. For example, the use of two belt drive motors 662 and 664 versus the three shown in Figure 10 allows for the apparatus 600 to be shortened, with motor 662 driving a belt 666 that moves three rollers 668, 669 and 670. The roller pair 144 is removed from this example of the invention as superfluous. The drive roller 166 in Figure 10 that raises the elevator 156 is partially eliminated by having the elevator drive belt 672 driven by the motor 674 and the attached spindle 676, which have been positioned in direct alignment with the drive belt 672 in Figure 12, instead of the right angle, double belt connection shown in Figure 10. Again, as the belt 672 moves far enough to display cards (not shown) on the elevator platform 612, the extension 614 presses against the edge 613 of the cover section 604, elevating the cover top 602. The apparatus 600 is actually preferably configured with the sections 604 and 606 separated along area 680 so that they move independently. By separating these sections 604 and 606, only the cards readied for delivery are exposed, and access to the area 682 where unshuffled cards are to be inserted is more restricted, especially where, as noted above, a tool or implement is needed to raise the cover section corresponding to 606 so that the unshuffled cards may not be too readily accessed.

In Figure 15, the motors **662**, **664** and **674** are preferably highly controlled in the degree of their movement. For example, one of the methods of providing precise control on motor movement is with micro stepped motors. Such micro stepping of motors controls the precise amount of movement caused by the motor. This is especially  
5 important in motor **674** that drives the elevator platform **612** that in turn carries the cards (not shown) to be separated for random card insertion. With micro stepping, the movement of the cards can be readily controlled to less than a card thickness per micro step. With such control, with no more than 0.9 card thickness movement, preferably less than 0.8 card thickness movement, less than 0.5 card thickness movement, less than 0.4  
10 card thickness movement, less than 1/3 card thickness movement, less than 0.25 card thickness movement, less than 0.20 card thickness movement, and even less than .05 card thickness movement per micro step, much greater assurance of exact positioning of the elevator platform **612** and the cards thereon can be provided, further assuring that cards will be inserted exactly where requested by operation of the microprocessor. Sensing  
15 elements **684** may be positioned within the picker or grabbing element **686** to analyze the position of the picker with respect to cards being separated to determine if cards have been properly aligned with the picker **686** and properly separated. The elements **686** may alternatively be physically protruding sub-elements that grab small areas of cards, such as rubber or elastomeric bumps, plastic bumps, metal nubs, or the like. Sensors may  
20 alternatively be placed on other surfaces adjacent the picker **686**, such as walls **688** or **690** or other adjacent walls or elements. For increased security and enhanced performance, it is preferred that multiple sensors be used, preferably multiple sensors that are spaced apart with regard to edges of the cards, and multiple sensors (i.e., at least two sensors) that are positioned so that not only the height can be sensed, but also  
25 misalignment or sloping, or bending of cards at different locations or positions. The sensors can work independently of or in tandem with the microprocessor/step motor/encoder operation.

The micro step motors will also assist the apparatus in internal checks for the correct position. For example, an encoder can be used to check the exact position of the

elevator with regard to the measured movement and calculation of the precise movement of the elevator platform and hence the cards. The encoder can evaluate the position of the elevator platform through analysis and evaluation of information regarding, for example, the number of pulses/revolution of the spindle **676** on the motor **674**, which  
 5 may be greater than 100 pulses/revolution, greater than 250 pulses/revolution, greater than 360 pulses/revolution, greater than 500 or greater than 750 pulses/revolution, and in preferred embodiments, greater than 1000 pulses/revolution, greater than 1200 pulses per revolution, and equal to or greater than 1440 pulses/revolution. In operation, the microprocessor moves the motor, the encoder counts the amount of movement driven by  
 10 the motor, and then determines the actual position of the elevator platform or a space (e.g., four cards higher) relative to the elevator platform. The sensors may or may not be used to determine the correct position, initially calibrate movement and sensing positions on the platform, or as a security check.

An additional design improvement with respect to the apparatus of Figure 9 and that of Figures 14 and 15 is the elimination of a staging area in the apparatus design of Figure 9. After a card (not shown) in Figure 9 passes from rollers **140** to rollers **144**, but before being passed to rollers **146**, the card would be held or staged by rollers **144**. This can be eliminated by the design of rollers shown in Figures 14 and 15, with the movement of the cards timed to the movement of the elevator platform and the separation  
 20 of the cards by the pickers.

The apparatus **500** shown in Figure 14 is also provided with an outer flange **528** extending around an upper edge of the top surface that may be used to attach and support the apparatus **500** to a table or support the apparatus **500** so that the surface **517** is relatively parallel to the surface of the table or surface.

25 The use of a shuffler whose shuffling mechanism is concealed completely beneath the gaming table surface potentially poses security issues to a casino. In the event of a system malfunction, the dealer might not be aware that a shuffling sequence has failed. Since there is no way to visualize the shuffling routine, and in order to avoid instances where the display lights may malfunction and erroneously show a shuffling sequence has



been completed, an added level of security has been provided to the shuffler of the present invention.

According to the present invention, a number of cards to be randomized and the order of insertion of each card into the card randomizing or shuffling compartment is predetermined by the random number generator and microprocessor. By adding an encoder to the motor or motors driving the elevator, and by sensing the presence of groups of suspended cards, the MPU can compare the data representing the commands and the resulting movements to verify a shuffle has occurred. In the absence of this verification, the shuffler can send a signal to the display to indicate a misdeal, to a central pit computer to notify management of the misdeal, to a game table computer, if any with an output display to notify the dealer of a misdeal, to a central computer that notifies security, to a central system for initiating maintenance calls or combinations of the above.

Such a system is referred to as a "closed loop" system because the MPU creates the commands and then receives system signals verifying that the commands were properly executed.

Although the dealer control panel and display in the above examples of the present invention are located on the card shuffler, the present invention contemplates user-operated remote controls, such as a foot pedal, an infra-red remote control, the input of commands from a remote keyboard in the pit or other device initiated by a dealer or by management. Unlike the shuffler operation driven by software from a game computer, pit computer or central computer system, the shuffler of the present invention is controllable by an operator using remote equipment such as what is described above.

Although the randomizing system has been described as a vertically disposed stack of cards with a means for gripping a portion of the cards, and lowering the remaining cards to form two separate subgroups, forming an insertion point, the invention contemplates the use of a shuffler with a carousel-type card collection area. The gripping pads in this example of the invention grip a portion of cards that are horizontally disposed, and the card collection area rotated to create an insertion point for the next card. The cards are pushed out one at a time, or in groups to a card collection area.

Referring now to Figure 16, a perspective view of a shuffling machine **600** of the present invention is shown mounted to a shuffler support plate **602** behind a gaming table **(not shown)** that may or may not be modified to accommodate placement of the support plate **602**.

5           In this example of the invention, cards are loaded into an in-feed tray **606**. In one example of the invention **(not shown)**, the lower surface of the in-feed tray is substantially horizontal and is provided so that cards can be loaded into the top **608** of the shuffler, and then lowered beneath the gaming table surface for randomization.

10           The in-feed elevator may be equipped with a card support structure similar to the support structure surrounding delivery tray **612**, which in a preferred embodiment has two vertical supports and two sides are left open. Cards may be loaded into the in-feed tray **606** and into a card support structure **(not shown)**, and lowered automatically, in response to the dealer pushing downwardly on the top of the stack of cards or upon a signal received from the dealer controls **(not shown)**.

15           In this example of the invention, the loading station is positioned near the playing surface (for example, a casino table) and at the dealer's side, allowing the machine to be used without unnecessary strain or unusual needed physical movement on the part of the dealer. Loading and unloading large stacks of cards from the top of a machine that is mounted to eliminate lifting, straining or reaching large distances addresses a need long  
20           felt in the industry for a more ergonomically friendly card shuffler.

            The output tray elevator in the second described embodiment also includes a two-sided vertical structure **612** for supporting a group of randomized cards as the cards are raised to the top surface **608** of the shuffler. It is to be understood that the vertical support structures are preferably secured to the elevator platforms, but could also be  
25           secured to the frame, and attached in a manner to pop up into position when needed.

            A method of handling cards is described, including inserting the cards into a card in-feed tray, feeding the cards into a card randomization apparatus, capturing the randomized cards in a support structure and raising the cards and support structure to an upper surface of the shuffler. The method may comprise providing a retractable support

structure for extracting shuffled cards, inserting shuffled cards into the support structure while it is below the top surface of the device and moving the support structure to expose the cards and retracting the support structure both before and after card removal. The card in-feed tray may also be positioned on an elevator capable of lowering the group of cards into the apparatus prior to shuffling. When a second elevator is used, it is preferable to provide a retractable support structure for supporting the cards as the cards are lowered for shuffling.

The method preferably includes providing two separate support structures that support a vertically stacked group of cards on at least two surfaces, and preferably three. The support structure can be a solid three-sided box, could consist of three vertically disposed bars, two parallel plates and two angle irons to retain corners or any other structure that keeps the stack in vertical alignment, or other suitable support structure. The structure can be fixed to the upper surface of the shuffler, can be fixed to the elevators or can be affixed to the frame of the shuffler and constructed to “pop up” when needed for card loading and unloading. Cover plates, such as hinged or rotating plates, can be provided over the two elevators to provide additional cover (e.g., dust cover and visual cover) over the card source and the card collection areas to assure that visual inspection of the shuffling procedure can be reduced, and entry of foreign materials can be reduced. The cover plates should be light enough for the system to automatically lift the covers or for a dealer to easily lift the covers manually. The cards themselves may push up the cover plates, or a preceding post or element can be positioned on the elevator or supports attached or moving conjointly with the elevators to press against the interior surface of the cover plates to lift the plates in advance of contact with the cards.

The card reading capability, as described in greater technical detail later, can be used in a different number of modes and positions to get the benefits of the present invention. The card reading capability (by some visual data-taking element, such as a camera, scanner, reflection scanner, image bit recorder, image edge detector, or any other subcomponent that can image a card or convert a visual image of the card into reproducible data) can be located at various positions within the shuffler where it can be

assured of imaging each card before it is removed from the shuffler. This preferably is being done in the present invention internally in a shuffling machine where cards are not removed one-at-a-time from a dealing end or fed as hands or groups of cards (but less than the entire set of cards) to be removed in a subgroup of the entire set of cards placed into the shuffler. In one example of the invention, a video camera is used as a rank/suit scanner

A desirable set of image capture devices (e.g., a CCD automatic camera) and sensors (e.g., light-emitting devices and light capture devices) will be described, although a wide variety of commercial technologies and commercial components are available. A preferred camera is the "Dragonfly™" automatic camera provided by Point Grey Corporation and includes a 6 pin IEEE-1394 interface, asynchronous trigger, multiple frame rates, 640x480 or 1024x724 24-bit true color or 8-bit gray scale images, image acquisition software and plug-and-play capability. This can be combined with commercially available symbol recognition software. The commercially available image recognition software is trained on card symbols and taught to report image patterns as specific card suits and ranks. Once a standard card suit/rank recognition program has been developed, the training from one format of cards to another becomes more simply effected and can be done at the casino table or by a security team before the shuffler is placed on the table. Position sensors can be provided and enhanced by one of ordinary skill in the art from commercially available components that can be fitted by one ordinarily skilled in the art. For example, various optics such as SICK WT2S-N111 or WL2S-E11; OMRON EE SPY302; or OPTEK OP506A may be used. A useful encoder can be purchased as US Digital encoder 24-300-B. An optical response switch can be provided as MicroSwitch SS541A.

The benefits of the present system may be used in those less preferred shuffling devices, including continuous shufflers, especially where the continuous shufflers monitor the position of cards in the shuffled set from which cards are removed for play of a game, so that a constant inventory of the number, suit, rank and position of each and all cards can be maintained. Numerous types of image data-taking devices or image capture

devices that can provide the image data necessary to “read” the symbols on the card sufficiently so as to distinguish individual card’s rank at least by rank and preferably by rank and suit (and any other special markings that may be present on cards for special games) are available or are readily within the skill of the artisan to be constructed. Such image capture devices may be continuous (rapid frame-by-frame) video cameras, digital camera, analog cameras, reader/scanners, edge response detectors, reflectance readers, and the like, and may optionally have lighting elements (for example, filament lighting, light emitting diodes, lamps, electromagnetic spectrum emitters of any type, and the like) present to improve the lighting during image capture. The cards can be read during the randomization procedure either when the cards are stationary or in motion, without any special stop positions or delays in the movement of cards. The cards are read in such a manner that the rank and suit of each card in a complete set of cards (e.g., all of the cards within the device) are identified in a randomized set by position of each card and the rank and suit of each card in each position. It is also important to note that in a shuffling mode, the final set of cards is a randomized set of cards and not merely a collection of cards in a slightly different order from an original set of cards (e.g., previously played, unshuffled, hand-mixed, or the like). In another mode, cards are passed through the scanner without being shuffled for the purpose of rapidly verifying the content of the deck. One possible way of distinguishing a randomized deck of cards from a merely mixed deck or programmed collection of cards would be to use a statistical analysis program, or using another criteria, such as where fewer than 100% of the cards in a final set of at least 52 cards are not within 10 cards distance from adjacent cards within an original set.

As a general statement, the card reading capability should be directed towards a face of the cards so that edge reading (which requires specially marked cards) is not practiced or required. To do this, the camera or other image data-taking element should view at least a symbol marked corner of a card. This is not a problem, as standard cards have their symbols (or suit and rank) in opposite corners so that rotating a card will leave the symbol in the same corner position for viewing. Given this background, the image

data-taking component (hereinafter, an “IDC” or alternatively referred to as an image capture device) could be located as follows. If there is a feeding mechanism that moves individual cards from a deck or set of initial cards (usually unshuffled or previously used in a non-intended order) into a preliminary position before shuffling, the IDC could be located below the insertion area of the cards so that the bottom card is read before removal and as each bottom card is read, the next bottom card is exposed to the IDC and is read. If top cards are removed one-at-a-time, then each top card as it is moved would be read from below by an IDC. This is less preferred as the IDC would be probably be maximally distanced from each card as it is read because of the height of the set of cards. The set of cards could be elevated to fix the IDC at an intermediate height to lessen this problem, but increased distance between the IDC and the cards would require better and more expensive optics and software.

If the set of cards is placed on a support and removed one-at-a-time from the bottom (preferably) or the top of the set of cards and moved directly into a shuffling operation (rather than stored, collected or buffered at this point), then the camera may be either directly below a transparent support (or expose through a hole in the support) or at a position outside of a dimension of the set of cards (e.g., if in a vertical stack that forms a box-like structure, outside of the area of the bottom of the box), such as at an opening between an initial card support area and away from pick off rollers or other first card moving elements within that area of the bottom, before a first set of rollers that exerts control over the card from the first card moving elements (e.g., braking rollers, speed up rollers, nip rollers with any function, vacuum support movers, etc.), or after the first set of rollers exerts control over the card from the first card moving elements. The first card moving elements and all other card moving elements (except where otherwise specified) shall be discussed as rollers (usually nip rollers, although the pick-off rollers are not a set of nip rollers), such as pick-off rollers for simplicity, it being understood that other card-moving systems (e.g., plunger, pushing plates, etc.) may be used.

The card value (e.g., suit and/or rank) may be read after the first set of pick-off rollers, after the first set of nip rollers past the pick-off rollers, after a third set of rollers

that exerts some control on the movement of cards after the first set of nip rollers, such as when (in the preferred structure of the invention) cards are individually moved from a set of rollers to be inserted into a space between subgroups of cards in a forming stack of shuffled/randomized cards. In those positions, with the cards moving face down within the shuffling device, the face of the cards can be readily observed by an IDC and an image taken.

Looking at Figure 17, the shuffling/randomizing device 800 is shown with an initial card set receiving area 802. A set of pick-off rollers 804 and 806 are shown. The pick off rollers (shown as two rollers 804 and 806, but one, two, three or more linearly aligned or arrayed rollers can be used) move a card (not shown) from the bottom of the set of cards (not shown) placed into the card receiving area 802 and through an access hole or slot 810 to a position where a second set of rollers 808 exert some control over the card exiting from the slot 810. As the card is moved past rollers 808 (which may be called braking rollers for convenience or speed up rollers, or any other term used in the jargon of the art), the face of the card with symbols thereon (not shown) is brought into focal area 816 where the camera (or other IDC) 814 may record the image of the face of the card. The card is at this time or subsequently also has control exerted by the next set of nip rollers 812, usually referred to as speed-up rollers as they may sometimes desirably be used with linear surface speeds slightly greater than the linear surface speed of the rollers 808. Certain of the individual rollers in roller pairs may be brake rollers, free turning rollers, or even stationary (not rotating) rollers to provide optional physical effects on the movement and tension on cards. The rollers 812 move the card (not shown) into an insertion space 818 which will be in an opening created between subgroups of cards (not shown) within elevator space 830. The shuffling operation itself will be explained in greater detail later herein.

As noted elsewhere, the IDC may operate in a continuous on mode (less preferred, primarily because of the volume of data that is produced, but the use of data screening or filtering software that concentrates on symbol imagery, as by only including data following light background to dark background changes may be used) or in a single

screen shot mode that is timed to the proper positioning of the symbol on the card in the focal area of the camera. Looking again at Figure 9, this can be seen and accomplished in a number of different ways. The time in which the various rollers **804**, **806**, **808** and **812** move the card from the initial card set receiving area **802** into the camera focal area **816** is quite consistent, so a triggering mechanism can be used to set off the camera shot at an appropriate time when the card face is expected to be in the camera focal area **816**. Such triggers can include one or more of the following, such as optical position sensors **820** and **822** within the initial card set receiving area **802**, an optical sensor **824**, a nip pressure sensor (not specifically shown, but which could be within either nip roller **808** and the like. When one of these triggers is activated, the camera **814** is instructed to time its shot to the time when the symbol containing corner of the card is expected to be positioned within the camera focal area **816**. The card may be moving at this time and does not have to be stopped. The card may be stopped if desired or if time is needed for the supported cards **832** to be moved to allow insertion of a card into the insertion plane **818** between subgroups of cards. The underlying function is to have some triggering in the device that will indicate with a sufficient degree of certainty when the symbol portion of a moving or moved card will be with the camera focal area **816**.

Figure 18 shows a vertical cutaway view of the shuffler **900** with card reading camera **916** therein. The various elements are shown in a different view, such as the pick off rollers **904** and **906** within the initial card set receiving area **902**. Sensor **920** is shown in Figure 9 as a card set sensor **920** that indicates that there are still cards in the initial card set area **902**. Sensor **928** is in a more favorable card sensing position to act as a trigger for the camera **916**. A set of sensors **922** and **926** operate as card position sensors to check for jamming, clearance, alignment, in-feed availability (into the elevator area **930**). The sensors **938** and **926** may also act to assure that a card to be fed into the elevator **930** is properly positioned and available to be inserted by insert rollers **912**.

A desirable set of image capture devices (e.g., a CCD automatic camera) and sensors (e.g., light-emitting devices and light capture devices) will be described, although a wide variety of commercial technologies and commercial components are available. A



preferred camera is the "Dragonfly™" automatic camera provided by Point Grey Corporation an includes a 6 pin IEEE-1394 interface, asynchronous trigger, multiple frame rates, 640x480 or 1024x724 24-bit true color or 8-bit gray scale images, image acquisition software and plug-and-play capability. This can be combined with  
5 commercially available symbol recognition software. The commercially available image recognition software is trained on card symbols and taught to report image patterns as specific card suits and ranks. Once a standard card suit/rank recognition program has been developed, the training from one format of cards to another becomes more simply effected and can be done at the casino table or by a security team before the smart discard  
10 rack 2h is placed on the table. Position sensors (e.g., 32h and 34h) can be provided and enhanced by one of ordinary skill in the art from commercially available components that can be fitted by one ordinarily skilled in the art. For example, various optics such as SICK WT2S-N111 or WL2S-E11; OMRON EE SPY302; or OPTEK OP506A may be used. A useful encoder can be purchased as US Digital encoder 24-300-B. An optical  
15 response switch can be provided as MicroSwitch SS541A.

Once the symbol has been imaged, a signal is sent to a central processor where the information of the suit and rank of the individual cards is processed according to the objectives of the system. After each card has been read, the individual cards are moved by rollers to be deposited in a card collection area. Cards are delivered into the card  
20 collection area by being placed on a support tray. The trigger may also activate a light that is used in conjunction with the image capture device to improve image capture capability.

All of the apparatus, devices and methods disclosed and claimed herein can be made and executed without undue experimentation in light of the present disclosure.  
25 While the apparatus, devices and methods of this invention have been described in terms of both generic descriptions and preferred embodiments, it will be apparent to those skilled in the art that variations may be applied to the apparatus, devices and methods described herein without departing from the concept and scope of the invention. More specifically, it will be apparent that certain elements, components, steps, and sequences

that are functionally related to the preferred embodiments may be substituted for the elements, components, steps, and sequences described and/or claimed herein while the same of similar results would be achieved. All such similar substitutions and modifications apparent to those skilled in the art are deemed to be within the scope and  
5 concept of the invention as defined by the appended claims.

The unique combination of the accurate imaging reading capability of the present system and the specific positioning capability and recording (indexing) of specific cards whose value (rank and suit) can be specifically identified and associated with a specific position with the final randomized set of cards, gives excellent security to the casinos and  
10 players. As the card sequences read from a shuffled set of final cards can be exactly known, this information can be used along with other security devices, such as table card reading cameras, discard trays with card reading capability, and the like, to add a high degree of certainty that a fair and honest game is being played at a specific location. Although the shuffling device of the present invention reads cards prior to randomization,  
15 it has utility in that once a group of cards has been shuffled, the next time the group is read, the composition of that shuffled group prior to reshuffling is known. Other systems that read cards after shuffling can also be used to determine a random card sequence.

Special bonus hands in games such as Let It Ride® poker, Three Card Poker® game, Crazy Four Poker™ and the like can be immediately verified by a central  
20 computer or the shuffler itself by indicating that a specific value or rank of hand was properly dealt to a specific position on the table. Present day security may sometimes have to hand verify an entire deck or set of cards, which can take 5-10 minutes of table down time. This is distracting to players and is an economic loss to the casino.

Although a description of preferred embodiments has been presented, various  
25 changes including those mentioned above could be made without deviating from the spirit of the present invention. It is desired, therefore, that reference be made to the appended claims rather than to the foregoing description to indicate the scope of the invention.